Updates to Selected Analyses from the *Performance of the Defense Acquisition System* Series

2017 SARs Update

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1. Introduction and Summary

In 2013, 2014, 2015, and 2016, the Department of Defense (DoD) produced annual reports on the *Performance of the Defense Acquisition System*.[1] We encourage the interested reader to consult those volumes for background on defense acquisition, spending levels, and trends as well as a range of analyses on cost, performance, and schedule of Major Defense Acquisition Programs (MDAPs) as well as contractor performance, the acquisition workforce, and source selection practices.

Here, we update selected sections from the *Performance of the Defense Acquisition System* series with recent data.[2] To provide continuity, we use the methodologies established in the original reports, noting corrections and improvements in the relevant sections.

We provide updates on four topics:

- **Nunn-McCurdy Breaches.** We present the Department of Defense's official list of Nunn-McCurdy breaches (Table 1) categorized by Component (Figure 1 and Table 3) and commodity type (Table 4).

- **Program Cost Performance (Development).** We examine MDAP development (Research, Development, Test, and Evaluation [RDT&E]) cost growth on both a cumulative and biennial basis. In addition to showing the data on a program basis with all programs weighted equally, we also present the analyses with each program weighted by its size in dollars.

  Of note, by program, cumulative cost growth for RDT&E has been stable since 2010 (see Figure 2). Median RDT&E program cost growth in the last two years (biennial period 2015-2017) has been 1 percent (see Figure 5).

- **Program Cost Performance (Procurement).** We examine MDAP procurement cost growth on both a cumulative and biennial basis. In addition to showing the data on a program basis with all programs weighted equally, we also present the analyses with each program weighted by its size in dollars.

  Of note, since 2013, quantity-adjusted cumulative unit-procurement flyaway cost growth has fallen from 7 percent in 2013 to 1 percent in 2017, at the median (see Figure 8). Quantity-adjusted unit-procurement flyaway cost growth in the last two years (biennial period 2015-2017) has been 0 percent at the median (see Figure 11).

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[1] See Under Secretary of Defense for Acquisition, Technology, and Logistics (USD[AT&L]) (2013), USD(AT&L) (2014), USD(AT&L) (2015), and USD(AT&L) (2016).

[2] We extracted the data for the cost growth analyses from the Defense Acquisition Management Information Retrieval (DAMIR) and Data Set capabilities within the Defense Acquisition Visibility Environment (DAVE) between October 2018 and February 2019. In May 2019, we added production data on JHSV from the December 2012 SAR. We extracted data for the schedule growth analyses from the same sources in May 2019.

- **Program schedule growth of cycle time (program start to IOC).** We look at the growth of cycle time of all active programs working towards or achieving IOC in a given year. Median schedule growth dropped from 2015 to 2016, mainly due to a combination of programs with substantial schedule growth obtaining IOC or restructuring and new programs starting. While the median dropped, the overall distributions in 2015, 2016, and 2017 are not significantly different (see Figure 15).

2. Nunn-McCurdy Program Breaches

Each Major Defense Acquisition Program (MDAP) is required by law to submit a Selected Acquisition Report (SAR) to Congress 30 days after the annual President's budget (PB) submission. Quarterly SARs are required under various other circumstances and shall be submitted within 45 days after the end of the fiscal-year quarter (see 10 U.S.C. § 2432). A SAR reflects what is included in the PB as well as a comprehensive summary of MDAP cost, schedule, and technical performance (requirements) measures. Historical SAR data serve as the primary sources for much of our program-level analysis due to their relative availability and comprehensiveness.

Common program cost metrics[3] (such as Program Acquisition Unit Cost (PAUC)[4], which considers total acquisition costs (i.e., RDT&E, procurement, military construction, and acquisition operation and maintenance costs)—and total (i.e., development and procurement) quantities, and Average Procurement Unit Cost (APUC)[5], which includes only procurement dollars and quantities) are codified in statute. The statute also requires that programs exceeding certain thresholds (measured by PAUC or APUC changes relative to their original and current program baselines) must go through a rigorous reexamination and, in some cases, certification to Congress along a variety of specified criteria. This process is commonly referred to as the "Nunn-McCurdy" process, named for the original sponsors of the legislation dating back to 1982 (see 10 U.S.C. § 2433).

Two types of breaches are called out in the Nunn-McCurdy process: *significant* and *critical*. A significant breach is the lower threshold and is intended to warn Congress that a program is experiencing significant unit-cost growth relative to its baseline. A critical breach signifies the cost growth is even higher, triggering the formal reexamination and certification process mentioned above. The criteria for a significant breach are 15 percent from the current baseline, or 30 percent cost growth in APUC or PAUC from the original baseline. A critical breach occurs when the program experiences 25 percent cost growth from the current baseline, or 50 percent cost growth from the original baseline.

As with the last published report (October 24, 2016), we continue to report Nunn-McCurdy statistics based on the DoD's official list of breaches from 1997 through December 2018 (see Table 1). The numbers of breaches per year are slightly different than in the DoD's 2013 and 2014 reports.[6] It is important to note that the National Defense Authorization Act (NDAA) for FY 2006 made changes to the Nunn-McCurdy statute by adding the requirement to report unit-cost growth from the original baseline in addition to the current baseline. This additional requirement caused a large spike in 2005 when 11

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[3] Here, "cost" is synonymous with the total amount of funding because it reflects the prices paid on contracts as well as program execution costs.

[4] 10 U.S.C. § 2432(a)(1), defines PAUC as "the amount equal to (A) the total cost for development and procurement of, and system-specific military construction for, the acquisition program, divided by (B) the number of fully configured end items to be produced for the acquisition program."

[5] 10 U.S.C. § 2432(a)(2), defines procurement unit cost as "the amount equal to (A) the total of all funds programmed to be available for obligation for procurement for the program, divided by (B) the number of fully configured end items to be procured."

[6] The DoD's prior reports used quarterly SARs, whose dates may not align with the exact breach reporting dates to Congress. The DoD also used to report breaches by SAR years, which do not align completely with calendar years because SARs can include information from the beginning of the next calendar year. In addition, canceled programs may not have a final SAR, and programs stop reporting at 90 percent of cost expended or quantity delivered.

programs had to report preexisting significant breaches. Thus, for historical comparisons, we need to compare performance in years since 2006.

Table 1. Official DoD List of Nunn-McCurdy Breaches (SAR Years 1997–2017)

Year	Critical	Significant#
1997		• Chem Demil-Legacy/NSCMD
1998		• FMTV • Javelin • Longbow Apache
1999	• ATIRCM/CMWS • B-1B CMUP	• NAVSTAR GPS/Satellite
2000		
2001	• CH-47F • Chem Demil-CMA/CSD • F-22 • GMLRS • H-1 Upgrades (4BW/4BN) • LPD 17 • Navy Area TBMD[a] • SBIRS High	• B-1B CMUP • MH-60R • V-22
2002	• ATACMS-BAT:BAT P3I[b]	• Comanche • SSN 774
2003	• EELV	• F-35
2004	• Chem Demil-CMA • Chem Demil-CMA Newport	• AEHF • RQ-4A/B UAS Global Hawk • SBIRS High
2005*	• NPOESS • RQ-4A/B UAS Global Hawk • SBIRS High	• ATIRMC/CMWS* • C-130 AMP* • Chem Demil-CMA* • Chem Demil-CMA Newport* • EFV* • F/A-18E/F* • JASSM* • JPATS* • MH-60S* • SSN 774* • ASDS[b] • GMLRS • F-35*
2006	• C-130 AMP • Chem Demil-ACWA • EFV • GMLRS • JASSM • JPATS • Land Warrior[b] • WIN-T	• FBCB2
2007	• C-5 RERP	• AEHF • ARH • JAVELIN • JTRS GMR
2008	• AEHF • ARH[a] • VH-71[a,d]	• H-1 Upgrades (4BW/4BN)
2009	• Apache Block III (AB3) • ATIRCM/CMWS • DDG 1000 • E-2D AHE • F-35 • RMS • WGS	• C-130 AMP
2010	• Chem Demil-ACWA • EFV[b] • Excalibur • RQ-4A/B UAS Global Hawk	• C-27J • Inc1 E-IBCT[b] • JLENS • NPOESS
2011	• AIM-9X Block I[b] • C-130 AMP[b] • JLENS[c] • JTRS GMR[a]	
2012	• EELV	
2013	• JPALS Inc 1A • VTUAV	• AWACS Block 40/45 Upgrade • JTRS HMS
2014	• JSOW[b]	• WIN-T (Inc 2)
2015	• RMS[b]	
2016	• OCX	• Chem Demil-ACWA
2017	• AAG[e] • IDECM[f]	• LCS MM

Programs that declared a significant breach and subsequently a critical breach in the same SAR year are listed only as critical breaches. Programs that declared multiple significant breaches in the same SAR year are listed only once.

* Programs in purple shading (2006–2015 for critical; 2005–2015 for significant) breached against the original baseline as per the FY 2006 NDAA. Programs in blue shading (1997–2005 for critical; 1997–2004 for significant) breached according to prior criteria that allowed re-baselining. Eleven programs that did not have a breach prior to the new FY 2006 criteria had significant breaches as a result of this legislative change. The FY 2006 NDAA also permitted the following 25 programs to revise their original baselines to equal their current baseline estimates as of January 6, 2006, without declaring a critical breach: AEHF; AMRAAM; ASDS; Black Hawk Upgrade; Bradley Upgrade; C-17A; CH-47F; EELV; F-22A; FCS; FMTV; Global Hawk; GMLRS; Javelin; JSOW; H-1 Upgrades; Longbow Apache; LPD-17; MH-60R; Minuteman III Guidance Replacement Program; NPOESS; SBIRS High; T-45TS; Trident II Missile; V-22. Program abbreviations are defined in Appendix A.

a Following a declared breach, the program was terminated rather than certified.

b Breach resulted from a decision to terminate the program.

c Breach resulted from a decision to terminate procurement phase; Engineering, Manufacturing and Development (EMD) units were completed.

d DoD did not submit a December 2008 SAR to Congress. The VH-71 breach was reported in the March 2009 SAR, but the breach occurred in the 2008 reporting period.

e AAG was directed to report a critical Nunn-McCurdy breach in the FY 2017 NDAA using their FY 2009 ACAT II APB as the original estimate. The out-of-cycle Nunn-McCurdy SAR was submitted on May 15, 2017 but is not used as the initial SAR for the program.

f Breach resulted from a quantity reduction.

Breaches have various causes. As examples, Table 2 discusses causes of critical Nunn-McCurdy breaches that occurred after the 2016 *Performance of the Defense Acquisition System* report was published.

Table 2. Official DoD Assessment of Root Causes of SAR Year 2017 Critical Nunn-McCurdy Breaches

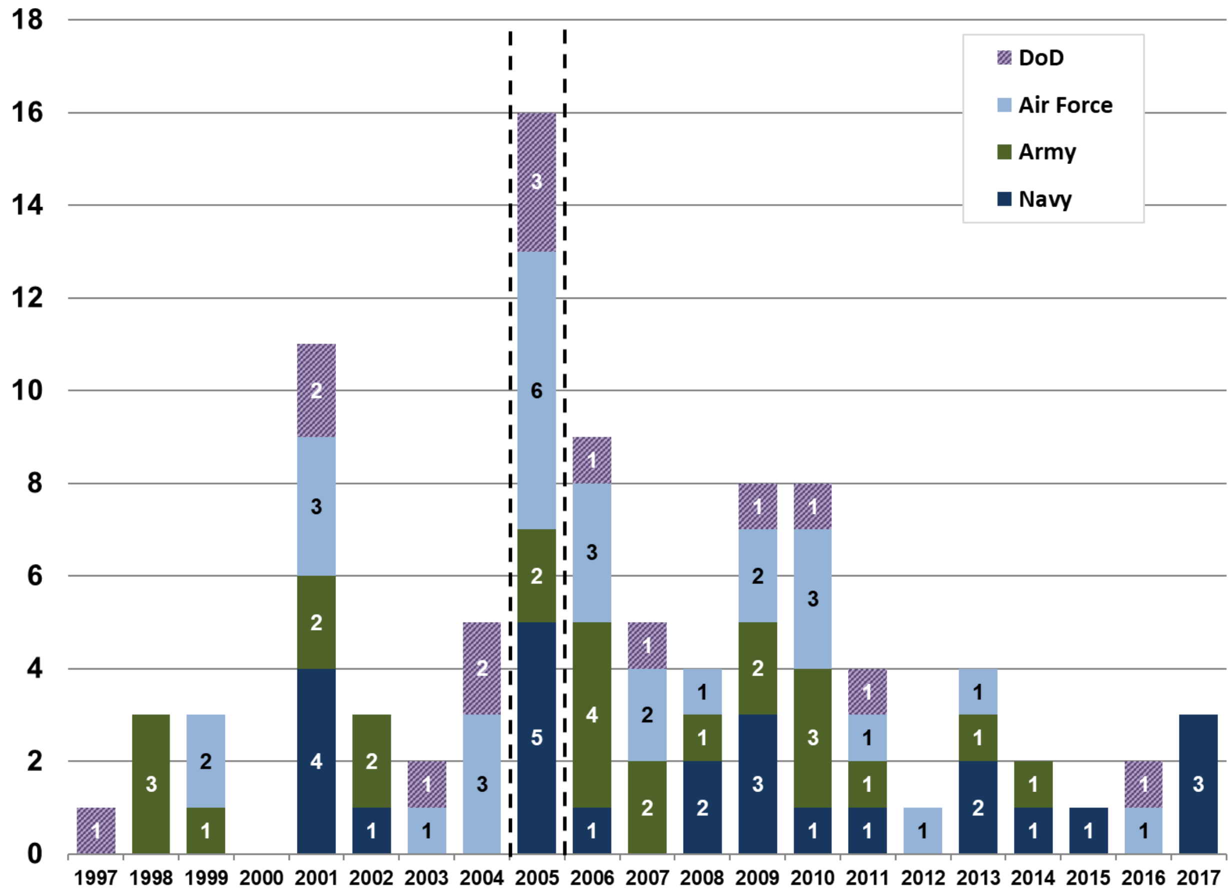
MDAP	Causes
AAG	The primary source of this breach is Research, Development, Test and Evaluation (RDT&E) funding, which grew from $301.0 million to $960.7 million in constant year 2004 dollars (CY 2004$). 85.5 percent of this growth or $563.8 million (CY 2004$), was driven by full scale test failures, as the majority of hardware components in the AAG system had to be redesigned and extensive software changes implemented radically impacted both schedule and cost. The remaining 14.5 percent of total RDT&E cost growth, $95.7 million (CY 2004$), is due to the addition of scope to the program since 2009 for life-cycle support items such as a Software Support Activity, the conduct of Depot Planning, and the development of a permanent training solution.
IDECM Block 2/3	The root cause of the IDECM critical breach was a quantity change unrelated to program execution.

2.1 Breaches by Component

One measure of acquisition program cost performance is the Nunn-McCurdy breach rate by DoD Component. In this analysis, "DoD" programs are programs categorized as such in the SARs, which include joint programs and programs (such as Chem Demil) overseen by an organization other than the Air Force, Army, or Navy.[7] Figure 1 shows significant and critical Nunn-McCurdy breach numbers by year from 1997 through 2017. This chart aligns with the DoD official breach list (Table 1). The Navy's AAG, IDECM (Block 2/3), and LCS MM programs are the three 2017 breaches.

[7] This analysis attributed programs to the same DoD Component as USD(AT&L) (2016). Additionally, the following Navy programs released their first SAR in 2016 or 2017: AAG, ACV 1.1, IRST, NGJ Inc 1, OASuW Inc 1 (LRASM), T-AO 205 Class, and SSBN 826. The following Army programs released their first SAR in 2016 or 2017: M88A2 HERCULES, CH-47F Block II, and CIRCM. The following Air Force programs released their first SAR in 2016: B-2 DMS-M, F-15 EPAWSS, and MGUE Inc 1.

Figure 1. Nunn-McCurdy Significant and Critical Breaches by DoD Component (SAR Years 1997–2017)



NOTE: The criteria for breaches were changed in NDAA 2006, so the counts before 2005 are different than those since 2006, and 2005 was a transition year and not comparable to either half. Breaches are determined using “base- year” dollars (i.e., adjusting for inflation). This plot includes the number of breaches in each annual SAR cycle, which nominally equates to calendar year but may include updates early in the following calendar year from the President’s Budget Request. Breaches in different years for different thresholds or baselines for the same program are included in each respective year. If a program reported both a significant and critical breach in the same year, only one breach is shown here.

Table 3 summarizes a different analysis of Nunn-McCurdy breaches by DoD Component. Here we do not “double count” programs that have breached multiple times. This allows us to get a sense of the tendency of programs to breach within each DoD Component. All breaches are listed regardless of cause. If a program had both a significant and a critical breach, it was included only in the “programs with critical breach” column.

Historically, about a third of MDAPs breached at least the significant threshold (i.e., about two- thirds have cost growth below 15 percent). At least two-thirds of programs that breach at the significant level eventually also breach the critical threshold (i.e., fewer remain at the significant level), except for Army programs, which are more evenly split between significant- and critical- breaching programs.

Table 3. Nunn-McCurdy Breach Rate by DoD Component (SAR Years 1997–2017)

Component	Total # Programs	# Programs that Ever Breached	Breach Rate	# Programs with at Most a Significant Breach	# Programs with a Critical Breach
DoD	12	7	58%	1	6
Army	59	18	31%	8	10
Navy	71	20	28%	7	13
Air Force	60	16	27%	3	13
Total	**202**	**61**	**30%**	**19**	**42**

NOTE: The analysis used DoD's December 31, 2018 official list of Nunn-McCurdy breaches, which did not include any breaches reported in the December 2018 SARs. If a program had both a significant and critical breach, it was included only in the "# Programs with a Critical breach" column. Breaches are determined using "base-year" dollars (i.e., adjusted for inflation). This table includes all DoD programs that released a SAR with funding information during the time period and does not control for program maturity.

2.2 Breaches by Commodity

Table 4 below summarizes Nunn-McCurdy breaches by commodity.[8] As above, we do not "double count" programs that have breached multiple times. This allows us to compare the types of programs that have poor cost performance (as evidenced by crossing any Nunn-McCurdy threshold) to those that have never breached during this period. All breaches are listed regardless of cause. If a program had both a significant and a critical breach, it was included only in the "programs with critical breach" column.

Table 4. Fraction of MDAPs by Commodity Type with Any Nunn-McCurdy Breach (SAR Year 1997–2017)

Commodity Type	Total # of Programs	# of Programs That Ever Breached	Breach Rate	# of Programs with at Most a Significant Breach	# of Programs With At Least One Critical Breach
Chem Demilitarization	4	4	100%	1	3
Space Launch	1	1	100%	—	1
Helicopter	18	10	56%	5	5
Fixed-Wing Aircraft	27	10	37%	3	7
Satellite	14	5	36%	1	4
UAV	6	2	33%	—	2
Ship/Submarine	22	6	27%	3	3
C4ISR	55	12	22%	3	9
Ground Vehicle	14	3	21%	2	1
Munition/Missile	33	7	21%	1	6
Missile Defense	8	1	13%	—	1
Total	**202**	**61**	**30%**	**19**	**42**

NOTE: The table compares number of programs that have crossed any Nunn-McCurdy threshold to those that have never crossed a threshold. Breaches are determined using "base-year" dollars (i.e., adjusted for inflation). This

[8] This analysis uses the same commodity types as USD(AT&L) (2016).

table includes all DoD programs that released a SAR with funding information during the time period and does not control for program maturity.

3. Cost Performance: Development

3.1 Program Development Funding Growth: Cumulative

We now examine MDAP development cost-related performance at the program level, using total RDT&E funding growth as the metric. Program "cost" (e.g., as defined for PAUC and APUC) is synonymous with the total amount of funding because it reflects the prices paid on contracts as well as program execution costs. Generally, RDT&E must be funded regardless of how many units are produced. In that sense, they are a fixed cost for the DoD to arrive at the point where it can procure and field a capability. Thus, for RDT&E, we track total funding growth rather than by unit produced (e.g., as for PAUC and APUC) to avoid confusing the effects of even small quantity changes with growth in RDT&E. Since we measure growth compared to initial baselines, this measure can show significant increases when a program originally was planned to involve little RDT&E but received even modest additions to address changing threats or operational needs. Still, this approach provides a means for measuring total RDT&E funding control relative to original plans.

A primary reason for systematically measuring our performance is to determine objectively if we are improving. On the one hand, recent programs and contracts have less cost and schedule growth because they are newer and have had less time to realize any growth. On the other hand, waiting until they are complete will take many years—sometimes decades.

Rather than wait for the completion of programs before measuring their performance, we take the middle ground of controlling for immature programs in this set of analyses. The cost community generally has found that programs and contracts with large cost or schedule growth will begin reflecting it in their estimates by the time they have executed about 30 percent of their originally planned schedule. Thus, analyses in this report that control for maturity exclude newer programs that have not yet reached this point. This, of course, is not the final word, but it does allow us to reflect much of the anticipated performance problems and get a reasonable sense of recent performance.

While examining total RDT&E funding from each program's original baseline estimate is important to capture the overall growth since inception, it may not be the best choice for gaining insight into recent cost-growth management. When we analyze a program from inception, we are forced to carry all growth until the program or phase of the program ceases to be active. Programs currently executing well but that had a one-time increase in the distant past can appear to be poor performers in the long term. Therefore, we also measure biennial changes in total planned and actual RDT&E funding.

Figure 2 shows total cumulative RDT&E funding growth over original MS B baseline for each year's MDAP portfolio.[9] This is the most conservative measure since it ignores any revised baselines set after Nunn-McCurdy breaches. For each analysis, we first show the main portion of the distribution (between −10 percent and +100 percent growth) followed by a separate figure showing all outliers (especially

[9] Analysis was generally done at the subprogram level. Notable exceptions include the F-35 program for which the aircraft and engine data were combined as they were in USD(AT&L) (2016) and the Chem Demil-ACWA program for which the Pueblo and Blue Grass subprograms, which began filing separate SARs in 2017, were combined to provide continuity.

those with growth greater than 100 percent). Medians are the lines within each box. Gray-shaded columns in the table beneath each chart were periods with very low sample counts because SARs for all active programs were not made in those years due to new Presidential administrations. The “x” markers above the box mark the five largest instances of program funding growth (although outliers above 100 percent only appear on the outlier charts). These outlier charts are controlled for program maturity only. Notably, the data show considerable (and sometimes seemingly conflicting) differences between the medians and the averages (arithmetic means). This is because the data are highly skewed, and a single but very large outlier can have a large effect on the mean while not affecting the median.[10] In these cases, the best measure of central tendency is the median.

In addition to the addition of the 2016 and 2017 SARs, the analysis presented here also adds data on the Small Diameter Bomb I and the Joint High-Speed Vessel programs for the years when they were MDAPs.[11] Due to quantity cuts, both programs changed from Acquisition Category (ACAT) I to ACAT II programs and were consequently removed from the MDAP list. We also incorporated a correction to the PAC-3 [Missile Segment] data for 1997-1999.[12]

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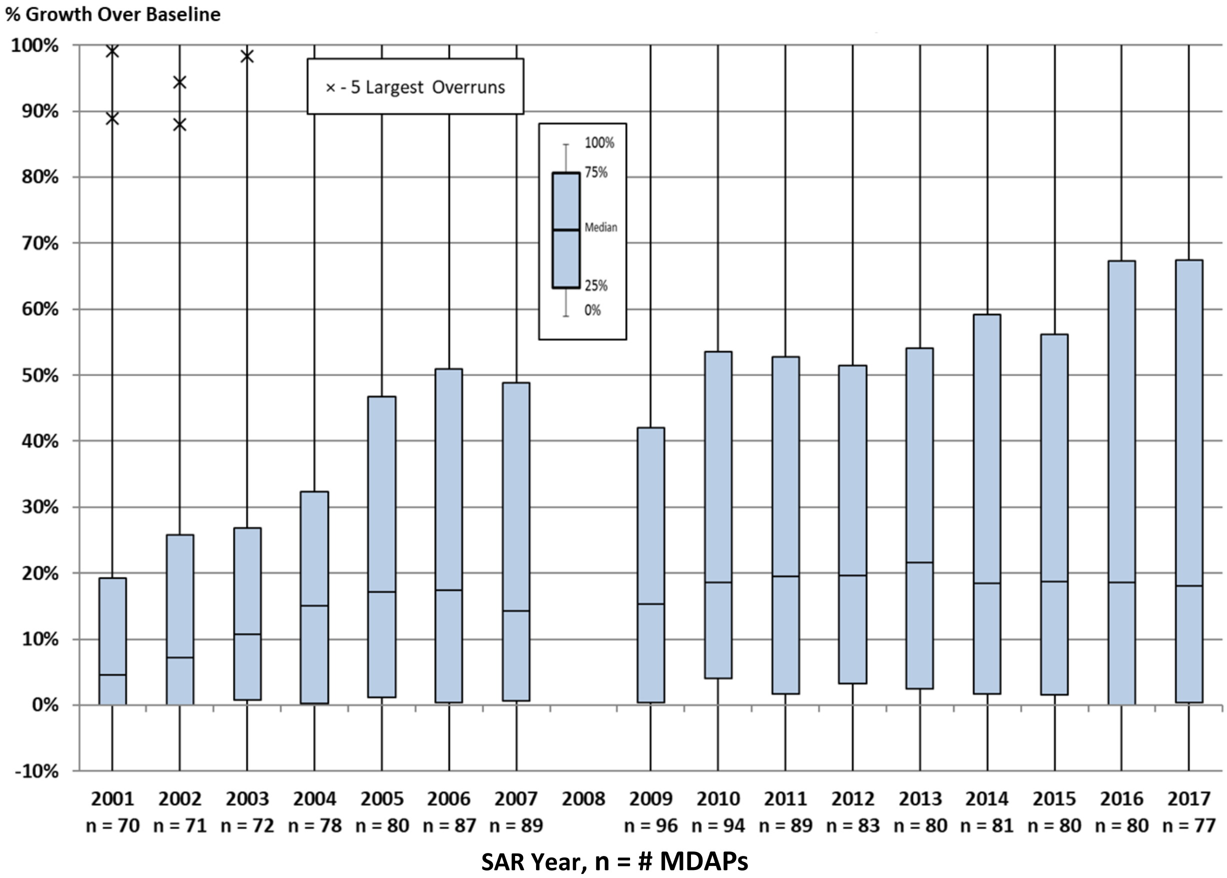
[10] Part of the skewing in the distribution of cost change is the mathematical boundary on cost change because cost cannot decrease more than 100 percent but can increase more than 100 percent.

[11] Small Diameter Bomb I was an ACAT I program from 2003-2007, and Joint High-Speed Vessel was an ACAT I program from 2009-2012.

[12] DAVE/DAMIR now contains SAR data for the PAC-3 [Missile Segment] subprogram starting with the September 2001 SAR. The removal of the 1997-1999 content changed the baseline used.

Figure 2. Development Cumulative Cost Growth:

Growth Over Original MS B Baseline of Active MDAP Planned Total (From Start to Completion) RDT&E Funding: Program Basis (Controlled for Maturity; SAR Years 2001–2017)



Median	5%	7%	11%	15%	17%	17%	14%		15%	19%	20%	20%	22%	18%	19%	19%	18%
IQR	19%	26%	26%	32%	46%	51%	48%		42%	50%	51%	48%	52%	58%	55%	67%	67%

NOTES: This shows total RDT&E funding growth independent of procurement funding and quantity changes; it reflects any work-content changes. These are percentage changes after adjusting for inflation from the original MS B baseline of actual past and estimated future funding as reported in each program's latest SAR.[13] We use the first SAR present in the Defense Acquisition Management Information Retrieval (DAMIR) system within the Defense Acquisition Visibility Environment (DAVE) dated after the program achieved MS B as the original MS baseline. Relatively new programs that have not spent at least 30 percent of their original EMD schedule are not shown. Boxes show first quartile, median, and third quartile; bars show first and third quartiles, minimum, and maximum. The IQR is the difference between the 75th and 25th percentiles.
A number of items account for the differences between this figure and the analogous figure from USD(AT&L) (2016): addition of SDB I and JHSV data for the years when the programs were MDAPs and incorporation of a correction to the PAC-3 [Missile Segment] data.

[13] For all of the development cost growth analyses, we adjusted for inflation using RDT&E deflators in the FY19 Green Book from the Under Secretary of Defense (Comptroller), Table 5-5, p. 60-61.

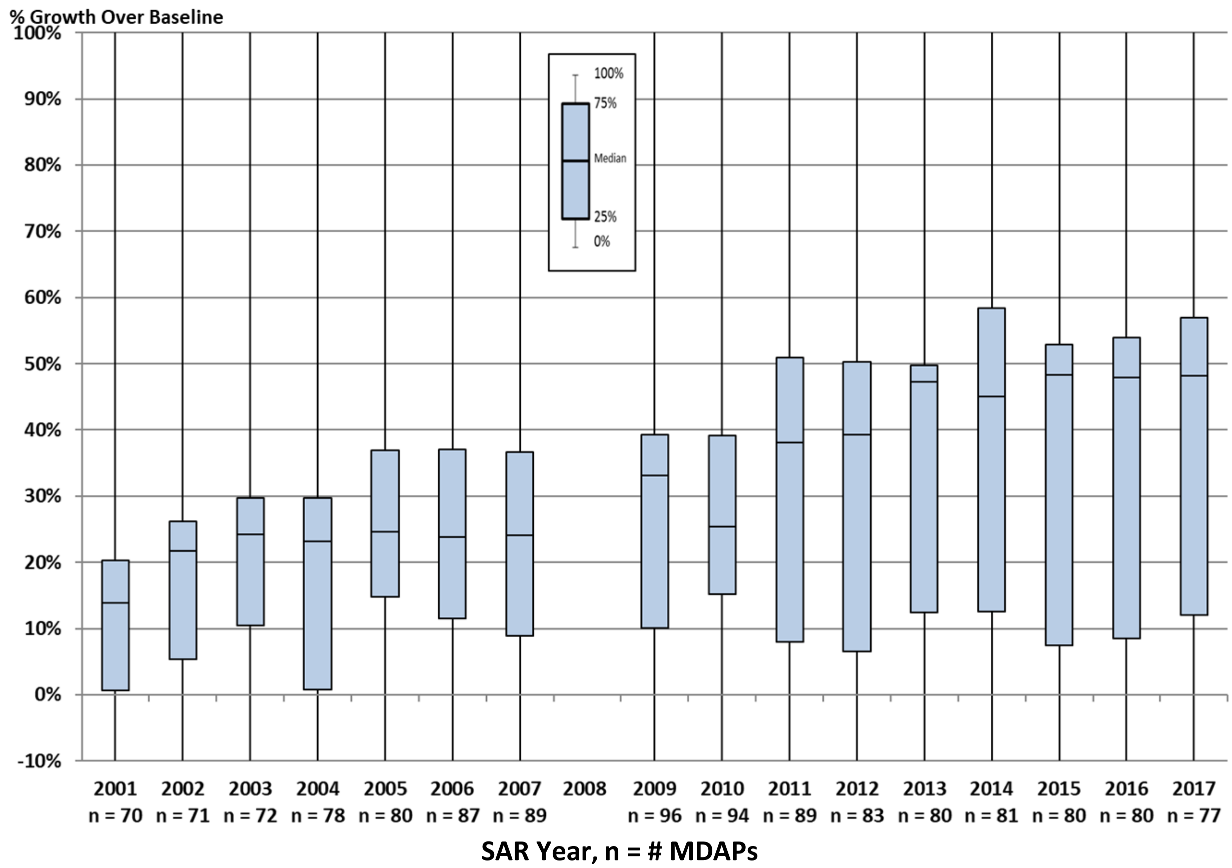
Growth up to and including 2017 has been statistically flat since the earlier years of 2001–2003, when the set of MDAPs active at that time had lower total RDT&E funding growth at the median.[14] In contrast to the results on a program basis, Figure 3 shows results on a dollar basis (i.e., weighted by program size in dollars).[15] As with the other analyses in this section, we controlled for maturity by removing programs that had not executed at least 30 percent of their original EMD schedule. Here, median growth has been trending upwards since 2001. In other words, larger programs (in terms of spending) have systematically larger total RDT&E funding growth, and that growth has been increasing. The F-35, for example, constitutes about 20 percent of the dollars in the current MDAP portfolio and thus has a large effect when weighted by program size (dollar basis). As the F-35 total RDT&E funding growth is above the median of the rest of the portfolio, it pulls the dollar-weighted median upwards. Also remember that here we are measuring growth against the original MS B baselines independent of any revised original baselines (due to program reconfigurations from Nunn-McCurdy breach).

[14] We used a Mann-Whitney test with a significance cutoff of 0.05 to compare the full “program basis” distributions (excluding immature programs) for each pair of years.

[15] We weighted each program’s development cost growth by the size of the program’s actual and planned RDT&E funding.

Figure 3. Development Cumulative Cost Growth (Weighted by Program Size in Dollars):

Growth Over Original MS B Baseline of Active MDAP Planned Total (From Start to Completion)
RDT&E Funding: Dollar Basis (Controlled for Maturity; SAR Years 2001–2017)



Median	14%	22%	24%	23%	25%	24%	24%		33%	25%	38%	39%	47%	45%	48%	48%	48%
IQR	20%	21%	19%	29%	22%	26%	28%		29%	24%	43%	44%	37%	46%	46%	45%	45%

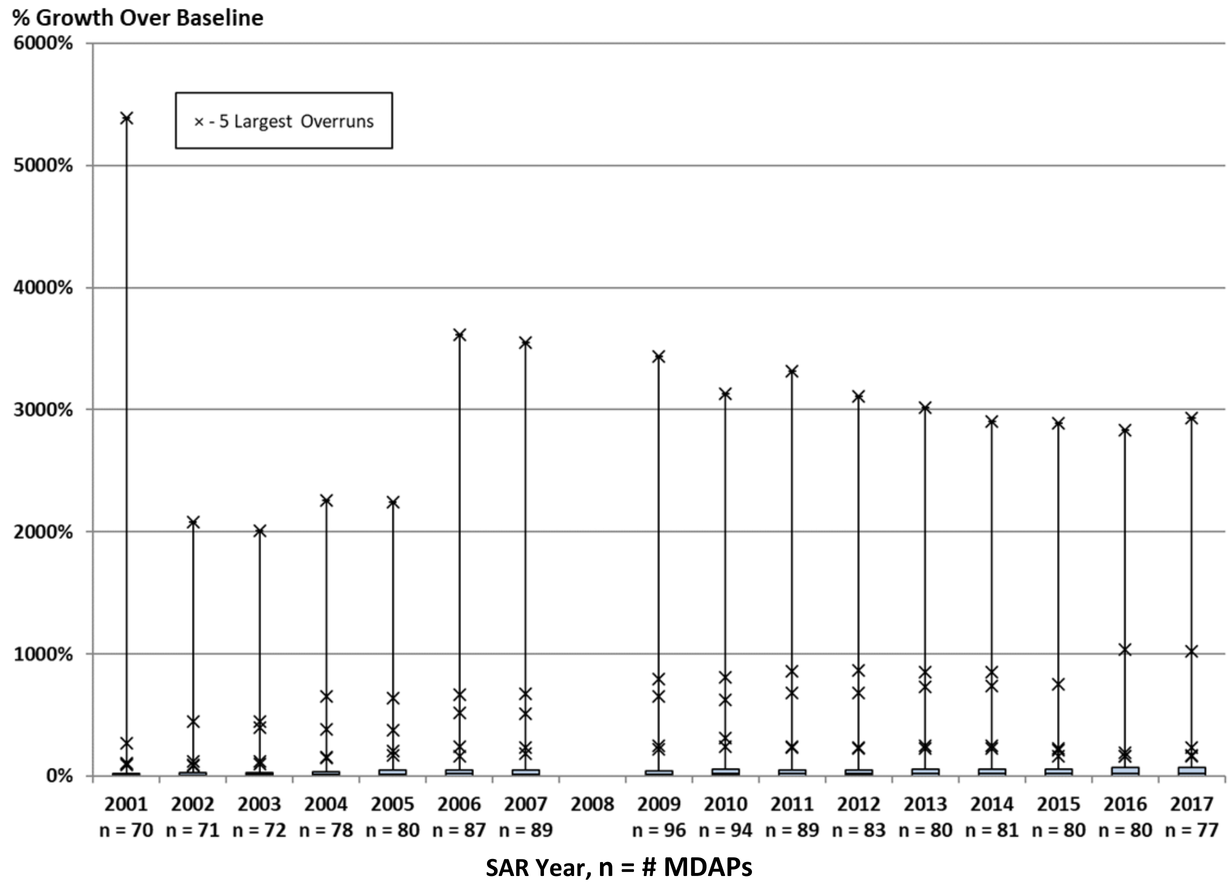
NOTES: This shows total RDT&E funding growth independent of procurement funding and quantity changes; it reflects any work-content changes. These are percentage changes after adjusting for inflation from the original MS B baseline of actual past and estimated future funding as reported in each program's latest SAR. We use the first SAR present in the DAVE/DAMIR system dated after the program achieved MS B as the original MS baseline. Relatively new programs that have not spent at least 30 percent of their original EMD schedule are not shown. Boxes show first quartile, median, and third quartile; bars show first and third quartiles, minimum, and maximum. The IQR is the difference between the 75th and 25th percentiles.
A number of items account for the differences between this figure and the analogous figure from USD(AT&L) (2016): addition of SDB I and JHSV data for the years when the programs were MDAPs and incorporation of a correction to the PAC-3 [Missile Segment] data.

Figure 4 shows the outliers, including some that are off the chart in Figure 2. The largest outliers in 2017 are the same as in 2016. These outliers have very large growth percentages but are not representative of the overall MDAP portfolio. These extreme growths are not due to measurement error and so were not excluded from the analysis. Still, they do skew the aggregate data, which is an important fact for determining how to measure and discuss funding growth across a program population. Similar skewing is observed in various complex commercial projects (see, for example, Flyvbjerg et al., 2002).

Understanding why a program may exhibit such a large percentage increase in RDT&E funding requires an individual examination of each case. For example, in Figure 4, the C-130J remains the highest outlier since 2002. This program originally was envisioned as a non-developmental aircraft acquisition with a negligible RDT&E effort planned. Several years into the program, a decision was made to install the Global Air Traffic Management system, adding several hundred million dollars to development and causing the total development funding growth to climb towards 3,000 percent. This is an example of a major change in the program rather than poor execution, although significant program changes like this are not necessarily the reason for all extreme cases of funding growth.

Figure 4. Development Cumulative Cost Growth:

Growth Over Original MS B Baseline of Active MDAP Planned Total (From Start to Completion) RDT&E Funding: Program Basis Outliers (Controlled for Maturity; SAR Years 2001–2017)



Largest Outlier	GML RS AW [Launcher]	C-130J							C-130J								
2nd Largest	MH-60S								MH-60S						GMLRS AW		
3rd Largest	CVN 68 [CVN-77]	SBIRS High	GMLRS AW						GMLRS AW						SBIRS High	AIM-9X Blk II	
4th Largest	SBIRS High	H-1 Upgrade	SBIRS High		RQ-4A/B Global Hawk				RQ-4A/B Global Hawk						AIM-9X Blk II	MIDS	
5th Largest	GMLRS AW		H-1 Upgrade	UH-60M Black Hawk	SBIRS High				SBIRS High						UH-60M		

NOTE: This shows total RDT&E funding growth independent of procurement funding and quantity changes; it reflects any work-content changes. These are percentage changes after adjusting for inflation from the original MS B baseline of actual past and estimated future funding as reported in each program's latest SAR. We use the first SAR present in the DAVE/DAMIR system dated after the program achieved MS B as the original MS baseline. X's mark the growth for the five largest outliers on each box-and-whisker chart. Program abbreviations are defined in Appendix A.

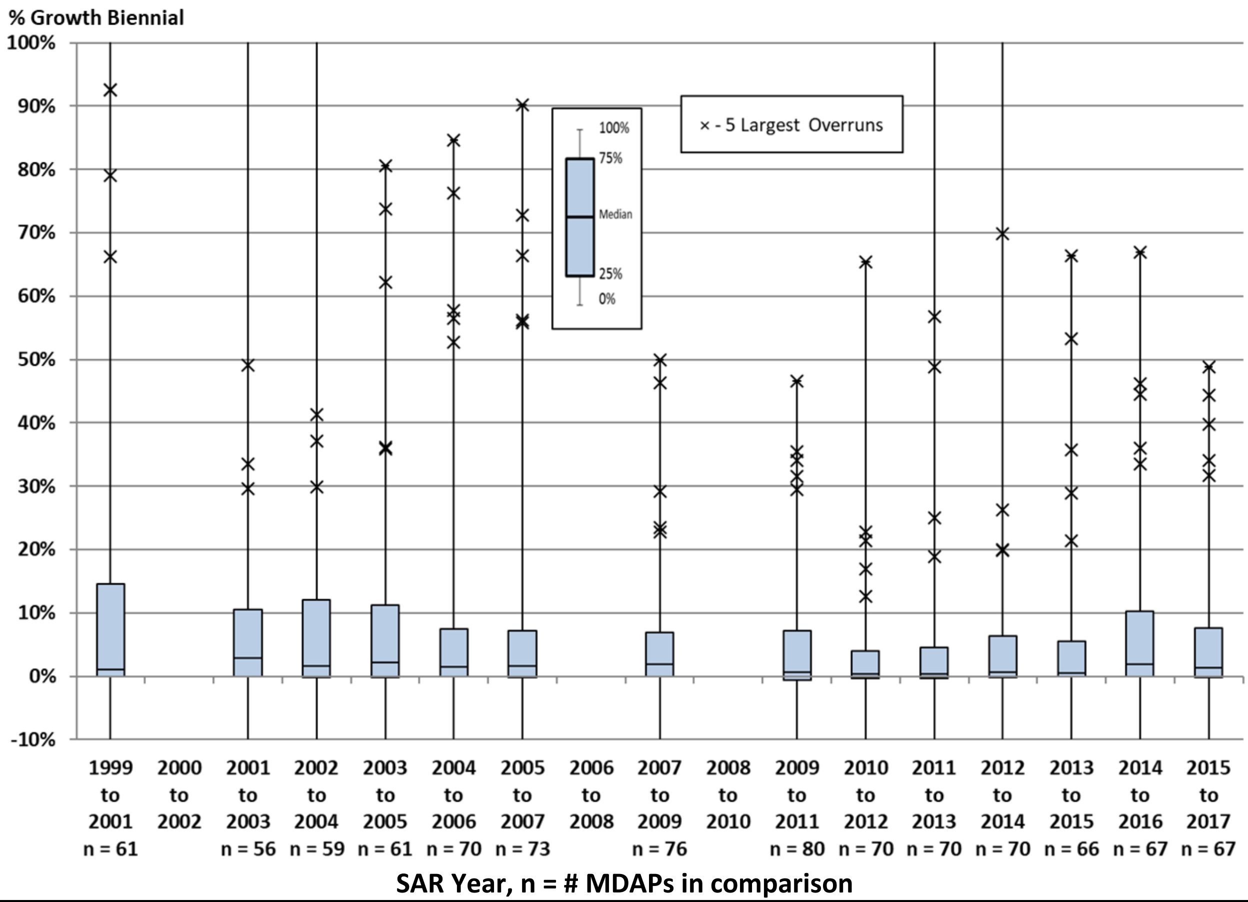
A number of items account for the differences between this figure and the analogous figure from USD(AT&L) (2016): addition of SDB I and JHSV data for the years when the programs were MDAPs and incorporation of a correction to the PAC-3 [Missile Segment] data.

3.2 Program Development Funding Growth: Biennial

Figure 5 and Figure 6 show a continuing low "marginal" cost growth when examining biennial changes in total (past plus planned) program RDT&E funding growth—both on program and dollar bases (weighted by program size in dollars). The 2017 results are not statistically different from 2016, although there has been a decrease in the spread above the median.[16]

Figure 5. Development Biennial Cost Growth:

Biennial Change in Active MDAP Planned Total (From Start to Completion) RDT&E Funding: Program Basis (Controlled for Maturity; SAR Years 1999–2017)



Median	1%		3%	2%	2%	1%	2%		2%		1%	0%	0%	1%	1%	2%	1%
IQR	15%		10%	12%	11%	7%	7%		7%		8%	4%	5%	6%	6%	10%	8%

NOTE: This figure shows biennial changes in total RDT&E funding growth independent of procurement funding and quantity changes; it reflects any work-content changes. These are percentage changes after adjusting for inflation from the original MS B baseline of actual past and estimated future funding as reported in each program's latest SAR. Relatively new programs that have not spent at least 30 percent of their original EMD schedule are not shown. Boxes show first quartile, median, and third quartile; bars show first and third quartiles, minimum, and maximum. The IQR is the difference between the 75th and 25th percentiles.
A number of items account for the differences between this figure and the analogous figure from USD(AT&L) (2016): addition of SDB I and JHSV data for the years when the programs were MDAPs and incorporation of a correction to the PAC-3 [Missile Segment] data.

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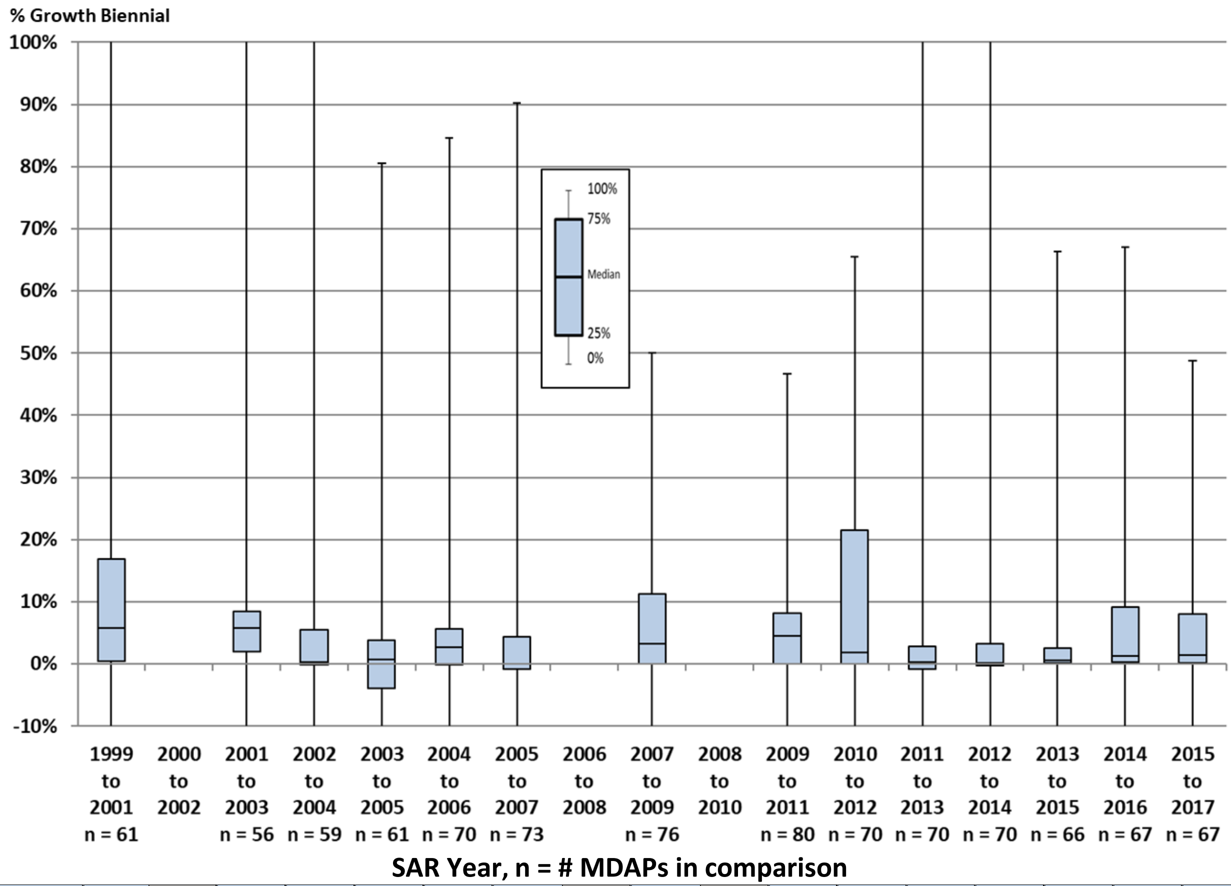
[16] We used a Mann-Whitney test with a significance cutoff of 0.05 to compare the biennial "program basis" distributions (excluding immature programs) for 2014 to 2016 and 2015 to 2017.

Figure 6. Development Biennial Cost Growth (Weighted by Program Size in Dollars)

Biennial Change in Active MDAP Planned Total RDT&E Funding (From Start to Completion): Dollar Basis (Controlled for Maturity; SAR Years 2001–2017)



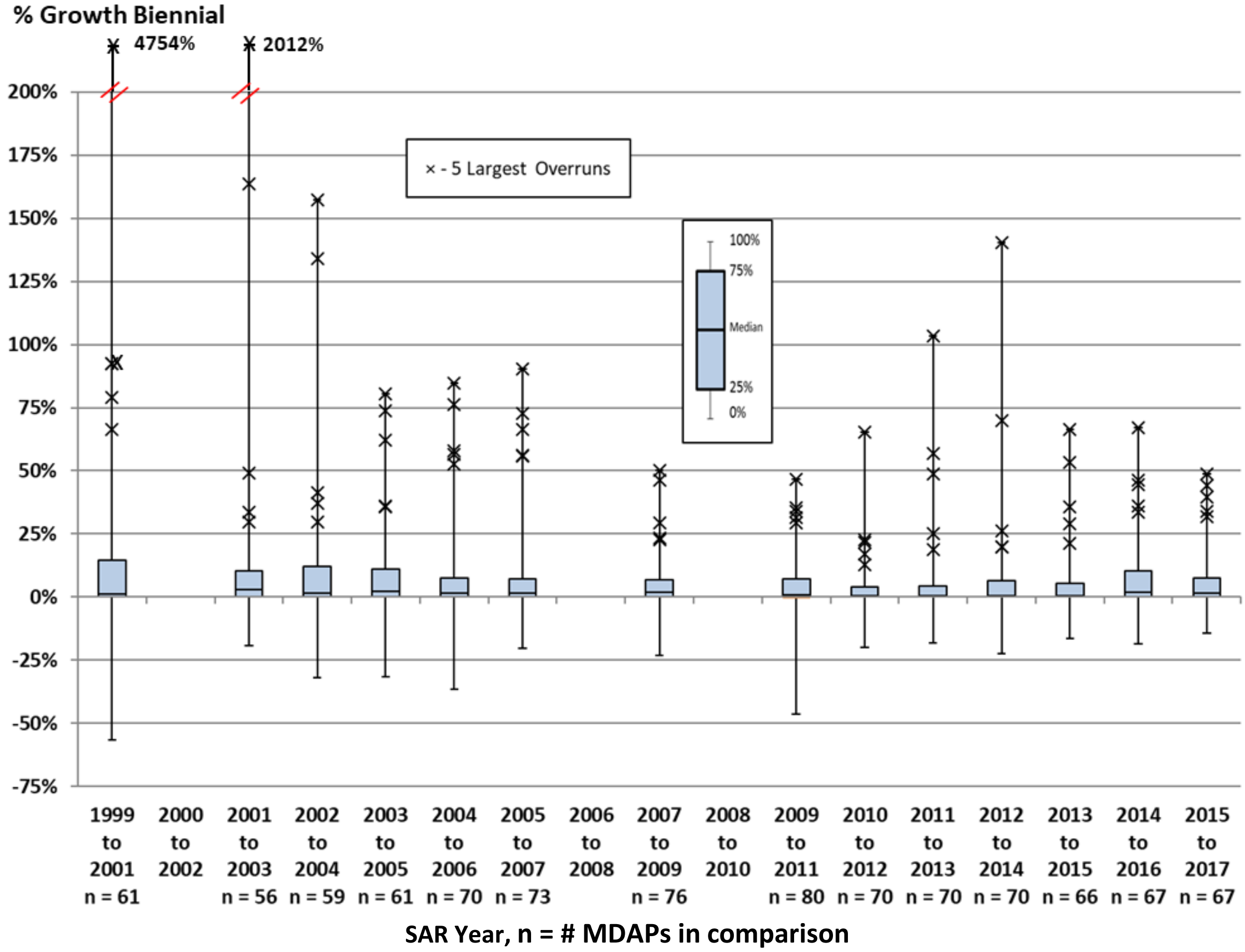
Median	6%		6%	0%	1%	3%	0%		3%		4%	2%	0%	0%	1%	1%	1%
IQR	17%		6%	6%	8%	6%	5%		11%		8%	21%	4%	4%	2%	9%	8%

NOTE: The chart shows biennial changes in total RDT&E funding growth independent of procurement funding and quantity changes; it reflects any work-content changes. These are percentage changes after adjusting for inflation actual past and estimated future funding as reported in each program's latest SAR. Relatively new programs that have not spent at least 30 percent of their original EMD schedule are not shown. Boxes show first quartile, median, and third quartile; bars show first and third quartiles, minimum, and maximum. The IQR is the difference between the 75th and 25th percentiles.
A number of items account for the differences between this figure and the analogous figure from USD(AT&L) (2016): addition of SDB I and JHSV data for the years when the programs were MDAPs and incorporation of a correction to the PAC-3 [Missile Segment] data.

Figure 7 shows the five largest programs with biennial changes in planned and actual RDT&E funding, controlling for program maturity. This includes outliers that are off the chart in Figure 5.

Figure 7. Development Biennial Cost Growth Outliers:

Biennial Change in Active MDAP Planned Total (From Start to Completion)
RDT&E Funding: Program Basis Outliers (Controlled for Maturity; SAR Years 1999–2017)



Largest Outlier	GMLRS AW Launcher		C-130J	GMLRS AW	JTN	WIN-T [WIN-T]	ARH		WIN-T INC 1		AH-64E Remanu-facture	MQ-9 Reaper	AIM-9X Blk II		EELV	JASSM-ER	IDECM Block 4
2nd Largest	CVN 68 [CVN-77]		GMLRS AW	UH-60M Black Hawk		SSDS MK 2 P3I	Chem Demil-ACWA		Patriot/ MEADS CAP [Missile]		STRYKER	F-35	JPALS	MQ-8 Fire Scout	AIM-9X Blk II	EELV	JASSM-ER
3rd Largest	GMLRS AW		MH-60S	WGS	JTRS GMR	C-130J	SSDS MK 2 P3I		LHA 6		JTRS HMS	MIDS	MQ-9 Reaper	JPALS	MQ-8 Fire Scout	OCX	
4th Largest	Chem Demil CMA CSD		NAVSTAR GPS Equipment	MH-60S	WGS	JTN	NAVSTAR GPS Equipment		WGS		MQ-1C Gray Eagle	E-2D AHE	MQ-8 Fire Scout	NMT		GMLRS AW	MQ-4C Triton
5th Largest	SBIRS High		WGS	MIDS		Chem Demil-ACWA	C-130J		GMLRS AW		FAB-T		E-2D AHE	EELV	OCX	MQ-4C Triton	GMLRS AW

NOTE: The chart shows biennial changes in total RDT&E funding growth independent of procurement funding and quantity changes; it reflects any work-content changes. These are percentage changes after adjusting for inflation of actual past and estimated future funding as reported in each program's latest SAR. Relatively new programs that have not spent at least 30 percent of their original EMD schedule are not shown. Boxes show first quartile, median, and third quartile; bars show first and third quartiles, minimum, and maximum. X's mark the growth for the five largest outliers on each box-and-whisker chart. Program abbreviations are defined in Appendix A.
A number of items account for the differences between this figure and the analogous figure from USD(AT&L) (2016): addition of SDB I and JHSV data for the years when the programs were MDAPs and incorporation of a correction to the PAC-3 [Missile Segment] data.

4. Cost Performance: Production

4.1 Program Procurement Cost Growth (Quantity Adjusted): Cumulative

Now examining production at the program level, the following figures summarize the unit procurement funding growth across the MDAP portfolio from the original MS B baseline and biennial changes. These analyses use recurring unit flyaway funding data reported in the SARs and are adjusted for quantity changes since the MS B baseline. As with the development funding analysis, we exclude relatively immature programs that have not executed 30% of their original EMD schedule.

These program-level data are for measures that (unlike PAUC and APUC) are fully adjusted for any changes in procurement quantity. These results help compare procurement unit costs at the initially estimated quantities, extrapolating data if quantities have been reduced. This approach provides a way of comparing what the units would have cost if we had not changed quantities by, essentially, measuring the shift in the procurement cost-versus-quantity curve from planned to actual.[17] In other words, we measure changes in procurement cost at the currently planned quantity to be purchased and assume that the original planned quantity still was being purchased. This approach allows us to examine on a unit basis the cost of the capability to acquire those units regardless of whether we increased or decreased quantity. Of course, quantity decreases may be due to unit-cost increases, and this approach will show such cost increases. It is also important to be aware that in 2017 the Army reported that it realigned direct civilian personnel pay costs from RDT&E and Procurement investment accounts, beginning in FY 2019, to Acquisition Operation and Maintenance to provide additional transparency. A majority of those civilian personnel pay costs came from the Procurement investment accounts.

Similar to the prior RDT&E results, growth distributions in production are highly skewed, with arithmetic means higher than the medians. The overall magnitudes of production funding growth are not nearly as large as those for RDT&E. There also is considerable variability in the production funding growth across the MDAP portfolio.

In addition to the addition of the 2016 and 2017 SARs, the analysis presented here also adds data on the Small Diameter Bomb (SDB) I and the Joint High-Speed Vessel (JHSV) programs for all the years when they were MDAPs.[18] Due to quantity cuts, both programs changed from ACAT I to ACAT II programs and were consequently removed from the MDAP list. When the final SAR for a year did not include learning curve data but an earlier SAR for that year did, we now include the learning curve data in the cumulative analyses, rather than just the biennial analyses.[19] Furthermore, to provide continuity, we combined the

[17] This basic approach for quantity adjustment is one of the standard techniques employed by the cost analysis community—see, for example, the discussions in Hough (1992), Arena et al. (2006, pp. 5–6), and Younossi et al. (2007, pp. 13-14).

[18] Small Diameter Bomb I was an ACAT I program from 2003-2007, and Joint High-Speed Vessel was an ACAT I from 2009-2012. The procurement analysis in USD(AT&L), 2016 used inconsistent program maturity dates and did not include JHSV production data from 2012.

[19] The final SARs for AESA (2001), B-1B CMUP [DSUP] (2002), JOINT COMMON MISSILE (2004), and JTRS GMR (2011) report on the programs' termination or incorporation into another program and do not include cost and quantity data suitable for a learning curve analysis. For each program, however, an earlier SAR for the year includes learning curve data. Except for JOINT COMMON MISSILE, the analysis considered all of the programs mature by the time of the final SAR.

F-35 aircraft and engine data as we did for the development cost growth analysis.[20] Aside from the F-35, however, we continue to focus the analysis at the subprogram level.

Figure 8 shows quantity-adjusted procurement cumulative unit-funding growth over the original MS B baseline for each year's MDAP portfolio on a program basis (controlled for program maturity).[21] Median growth in the two most recent years (2016 and 2017) has dropped to about 1 percent—the lowest value measured in the analysis period. Overall, the growth throughout the portfolio was statistically lower in both 2016 and 2017 than any of the years from 2001-2010 (excluding 2008, which had too few SARs to provide a sufficient sample).[22]

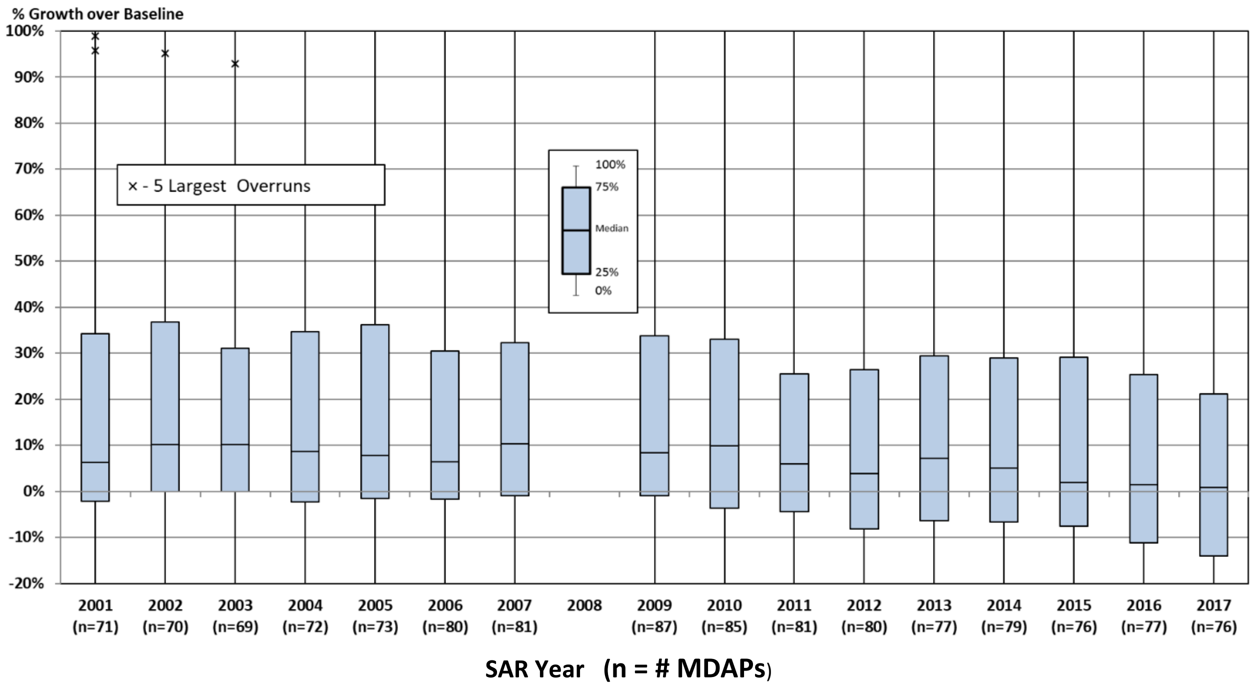
[20] Starting in 2011, the SARs separated the F-35 aircraft and engine data to comply with statutory requirements. The analysis in USD(AT&L) (2016) separated the F-35 aircraft and engine starting in 2011. That analysis used the Dec 2010 SAR, which included both the engine and the aircraft, as the baseline for the F-35 aircraft program and the 2003 SB as the baseline for the engine program. It considered the aircraft program mature starting in 2003 and the engine program mature starting in 2013. From 2003 (the program maturity date) though 2010, the USD(AT&L) (2016) "by program" analysis included combined F-35 aircraft and engine data using the December 2001 SAR as the baseline for 2003-2009 and the Dec 2010 SAR as the baseline for 2010. The USD(AT&L) (2016) "by dollar" analysis did not include the F-35 prior to 2010. From 2010 onwards, the "by dollar" analysis treated the data the same way the "by program" analysis did.

[21] We used the earliest post-MS B learning curve data available in DAVE/DAMIR as the baseline, regardless of whether it came from an APB, a SAR, or a SAR baseline.

[22] We used a Mann-Whitney test with a significance cutoff of 0.05 to compare the "program basis" distributions (excluding immature programs). We did not correct for multiple testing.

Figure 8. Procurement Cumulative Cost Growth:

Growth Over Original MS B Baseline of Active MDAP Planned Total (From Start to Completion)
Quantity-Adjusted Unit-Procurement Recurring-Flyaway Funding:
Program Basis (Controlled for Maturity; SAR Years 2001–2017)



Median	6%	10%	10%	9%	8%	6%	10%		8%	10%	6%	4%	7%	5%	2%	1%	1%
IQR	36%	37%	31%	37%	38%	32%	33%		35%	37%	30%	35%	36%	36%	37%	37%	35%

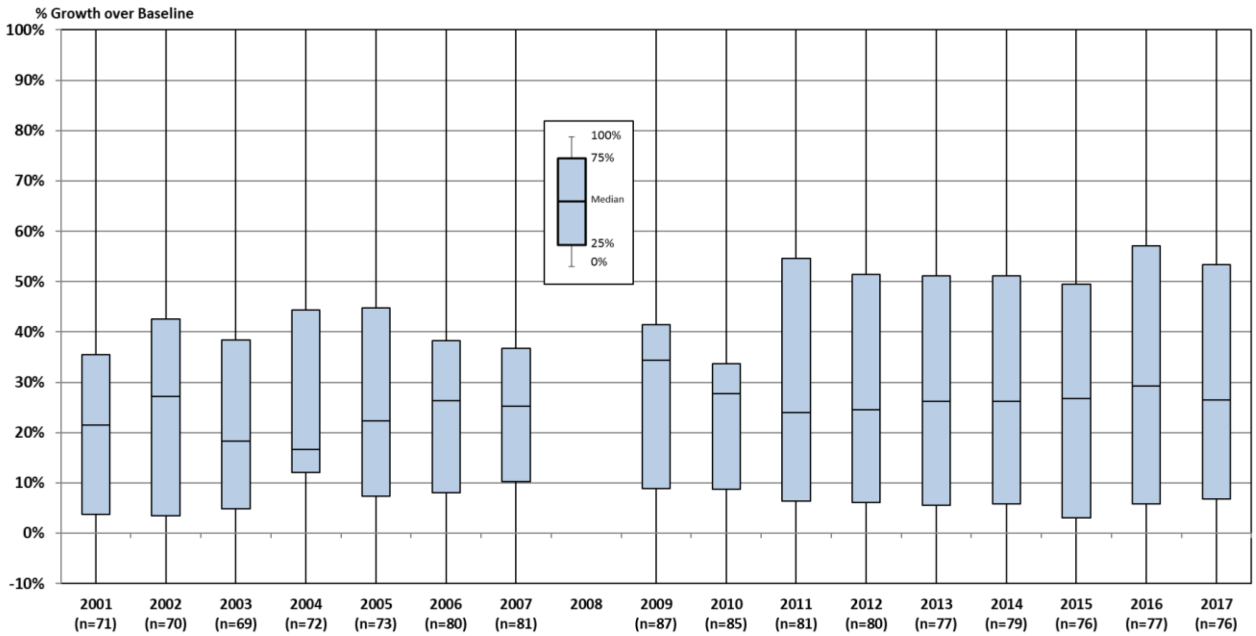
NOTE: The figure shows growth in unit recurring flyaway funding after adjusting for quantity changes; it is independent of RDT&E funding but reflects any work-content changes. These are percentage changes after adjusting for inflation and any quantity changes from the original MS B baseline of actual past and estimated needed future funding as reported in the programs' latest SARs.[23] Relatively new programs that have not spent at least 30 percent of their original EMD schedule are not included. Boxes show first quartile, median, and third quartile; bars show first and third quartiles, minimum, and maximum. The IQR is the difference between the 75th and 25th percentiles.
A number of items account for the differences between this figure and the analogous figure from USD(AT&L) (2016): addition of SDB I and JHSV data for all years when the programs were MDAPs; insertion of the final learning curve data for AESA, B-1B CMUP [DSUP], and JTRS GMR; and inclusion of a single F-35 data point for each year (via combination of aircraft and engine subprograms for years the SARs provided separate data) shown relative to the original F-35 MS B baseline.

Figure 9 shows results on a dollar basis (i.e., weighted by program size in dollars).[24] As with RDT&E funding growth, the median on a dollar basis is larger than the median on a program basis. Thus, larger programs (in terms of spending) have systematically larger unit procurement cost growth.

[23] For the procurement cost growth analyses, we adjusted for inflation using procurement deflators in the FY19 Green Book from the Under Secretary of Defense (Comptroller), Table 5-5, p. 60-61.
[24] We weighted each program's unit procurement cost growth by the size of the program's actual and planned recurring unit flyaway funding.

Figure 9. Procurement Cumulative Cost Growth (Weighted by Program Size in Dollars):

Growth Over Original MS B Baseline of Active MDAP Planned Total (From Start to Completion)
Quantity-Adjusted Unit-Procurement Recurring-Flyaway Funding:
Dollar Basis (Controlled for Maturity; SAR Years 2001–2017)



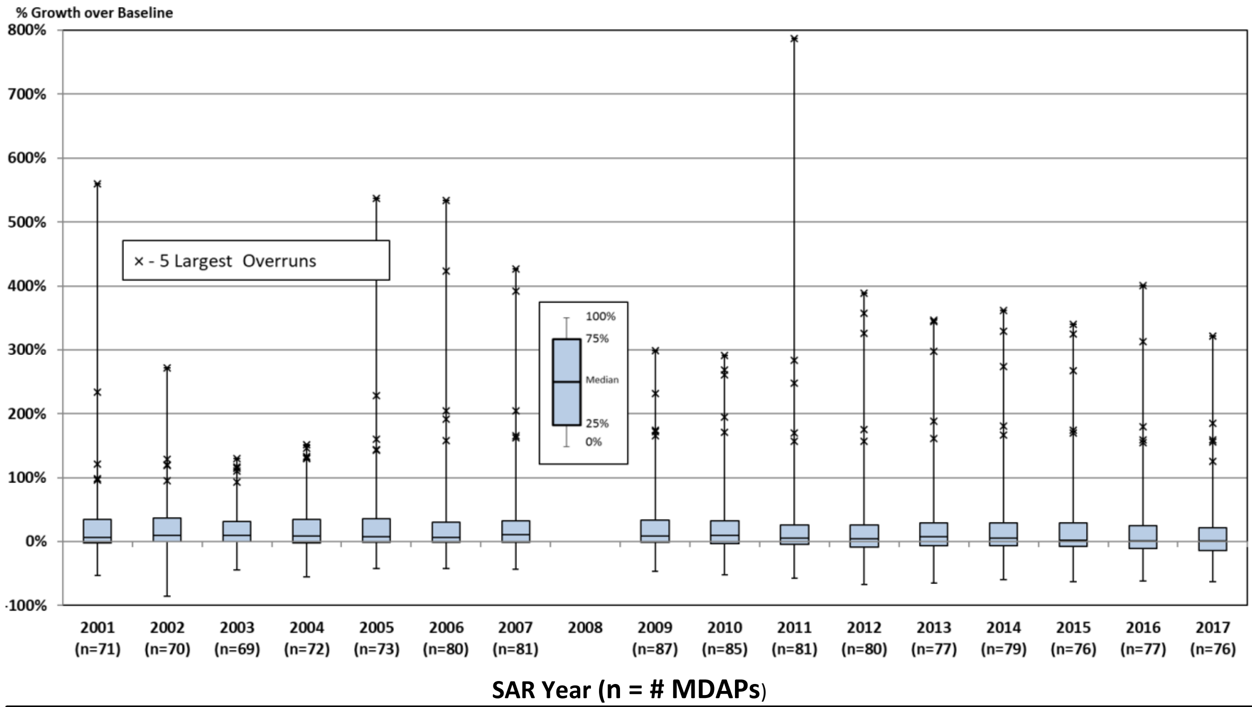
Median	21%	27%	18%	17%	22%	26%	25%		34%	28%	24%	25%	26%	26%	27%	29%	26%
IQR	32%	39%	34%	32%	37%	30%	26%		32%	25%	48%	45%	46%	45%	46%	51%	47%

NOTE: The figure shows growth in unit recurring flyaway funding after adjusting for quantity changes; it is independent of RDT&E funding but reflects any work-content changes. These are percentage changes after adjusting for inflation and any quantity changes from original the MS B baseline of actual past and estimated needed future funding as reported in the programs' latest SARs. Relatively new programs that have not spent at least 30 percent of their original EMD schedule are not included. Boxes show first quartile, median, and third quartile; bars show first and third quartiles, minimum, and maximum. The IQR is the difference between the 75th and 25th percentiles.
A number of items account for the differences between this figure and the analogous figure from USD(AT&L) (2016): addition of SDB I and JHSV data for all years when the programs were MDAPs; insertion of the final learning curve data for AESA, B-1B CMUP [DSUP], and JTRS GMR; inclusion of a single F-35 data point for each year (via combination of aircraft and engine subprograms for years the SARs provided separate data) shown relative to the original F-35 MS B baseline; and correction of a deflator error.

Figure 10 extends the y-axis scale to show all outliers in Figure 8, and the table at the bottom identifies the five largest funding-growth programs for each year. This chart is also controlled for program maturity. As a result of the AEHF SV1-4 program reaching the 90% expended mark and filing its final SAR in 2016, EELV became the largest outlier for 2017 and MQ-8 Fire Scout entered the top five.

Figure 10. Procurement Cumulative Cost Growth Outliers

Growth Over Original MS B Baseline of Active MDAP Planned Total (From Start to Completion) Quantity-Adjusted Unit-Procurement Recurring-Flyaway Funding: Program Basis Outliers (Controlled for Maturity; SAR Years 2001–2017)



<table>
<tr><td>Largest</td><td>SADARM Projectile</td><td>ATACMS BLK II/IIA</td><td>PAC-3 Fire Unit</td><td colspan="3">SBIRS High</td><td>NPOESS</td><td></td><td>SBIRS High</td><td>ATIRCM QRC</td><td>C-130 AMP</td><td colspan="2">EELV</td><td colspan="3">AEHF SV 1-4</td><td>EELV</td></tr>
<tr><td>2nd Largest</td><td>ATIRCM CMWS</td><td>PAC-3 Fire Unit</td><td>GMLRS AW</td><td>EELV</td><td colspan="2">NPOESS</td><td>SBIRS High</td><td></td><td>AEHF SV 1-4</td><td colspan="2">SBIRS High</td><td colspan="2">AEHF SV 1-4</td><td colspan="3">EELV</td><td>GMLRS AW</td></tr>
<tr><td>3rd Largest</td><td>PAC-3 Fire Unit</td><td>ATACMS BAT P3I</td><td colspan="2">CH-47F</td><td>GMLRS AW</td><td colspan="2">EELV</td><td></td><td>H-1 Upgrade</td><td colspan="2">AEHF SV 1-4</td><td colspan="4">SBIRS High</td><td>GMLRS AW</td><td>CH-47F</td></tr>
<tr><td>4th Largest</td><td colspan="2">GMLRS AW</td><td>EELV</td><td>GMLRS AW</td><td>EELV</td><td colspan="2">GMLRS AW</td><td></td><td colspan="2">C-130 AMP</td><td colspan="5">GMLRS AW</td><td>CH-47F</td><td>H-1 Upgrade</td></tr>
<tr><td>5th Largest</td><td>CH-47F</td><td>H-1 Upgrade</td><td>SBIRS High</td><td>PAC-3 Fire Unit</td><td colspan="2">CH-47F</td><td>C-130 AMP</td><td></td><td>GMLRS AW</td><td>EFV</td><td colspan="2">CH-47F</td><td>H-1 Upgrade</td><td colspan="2">JPALS</td><td>H-1 Upgrade</td><td>MQ-8 FireScout</td></tr>
</table>

NOTE: This shows growth in unit recurring flyaway funding after adjusting for quantity changes; it is independent of RDT&E funding but reflects any work-content changes. These are percentage changes after adjusting for inflation and any quantity changes from the original MS B baseline of actual past and estimated needed future funding as reported in the programs' latest SARs. Relatively new programs that have not spent at least 30 percent of their original EMD schedule are not included. Boxes show first quartile, median, and third quartile; bars show first and third quartiles, minimum, and maximum. X's mark the growth for the five largest outliers on each box-and-whisker chart. Program abbreviations are defined in Appendix A.

A number of items account for the differences between this figure and the analogous figure from USD(AT&L) (2016): addition of SDB I and JHSV data for all years when the programs were MDAPs; insertion of the final learning curve data for AESA, B-1B CMUP [DSUP], and JTRS GMR; and inclusion of a single F-35 data point for each year (via combination of aircraft and engine subprograms for years the SARs provided separate data) shown relative to the original F-35 MS B baseline.

4.2 Program Procurement Cost Growth (Quantity Adjusted): Biennial

Figure 11 shows biennial changes in total quantity-adjusted unit procurement funding (actual and planned), controlling for program maturity. The three periods 2009 to 2011, 2010 to 2012, and 2014 to 2016 are all statistically lower than the years 1999–2009.[25] The period from 2013 to 2015 is lower than all of the years from 1999-2009 except for 2004 to 2006. The most recent biennial period of 2015 to 2017 is statistically lower than 1999-2003, 2003 to 2005, 2005 to 2007, and 2007 to 2009. Thus, we have shown an improvement.

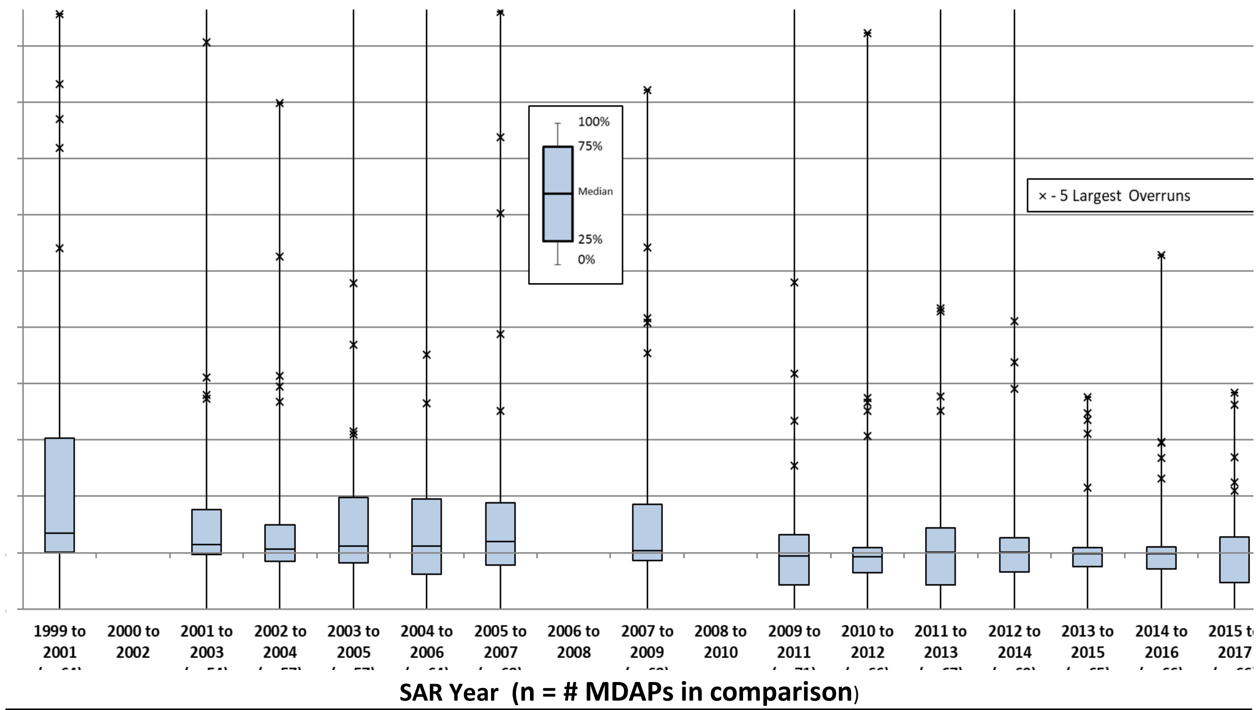
Figure 12 shows total quantity- adjusted unit procurement funding, but on a dollar basis.[26] On a dollar basis, the median growth from 2015 to 2017 was 1%, which was up slightly from the 0% median growth from 2014 to 2016.

[25] We used a Mann-Whitney test with a significance cutoff of 0.05 to compare the “program basis” distributions (excluding immature programs). We did not correct for multiple testing. Due to the low number of SARs available in 2000 and 2008, we did not consider the periods 2000-2002, 2006-2008, or 2008-2010.

[26] We weighted each program’s procurement growth by the size of the program’s actual and planned recurring unit flyaway funding.

Figure 11. Biennial Procurement Cost Growth:

Biennial Change in Active MDAP Planned Total (From Start to Completion) Quantity-Adjusted Unit-Procurement Recurring-Flyaway Funding: Program Basis (Controlled for Maturity; SAR Years 1999–2017)

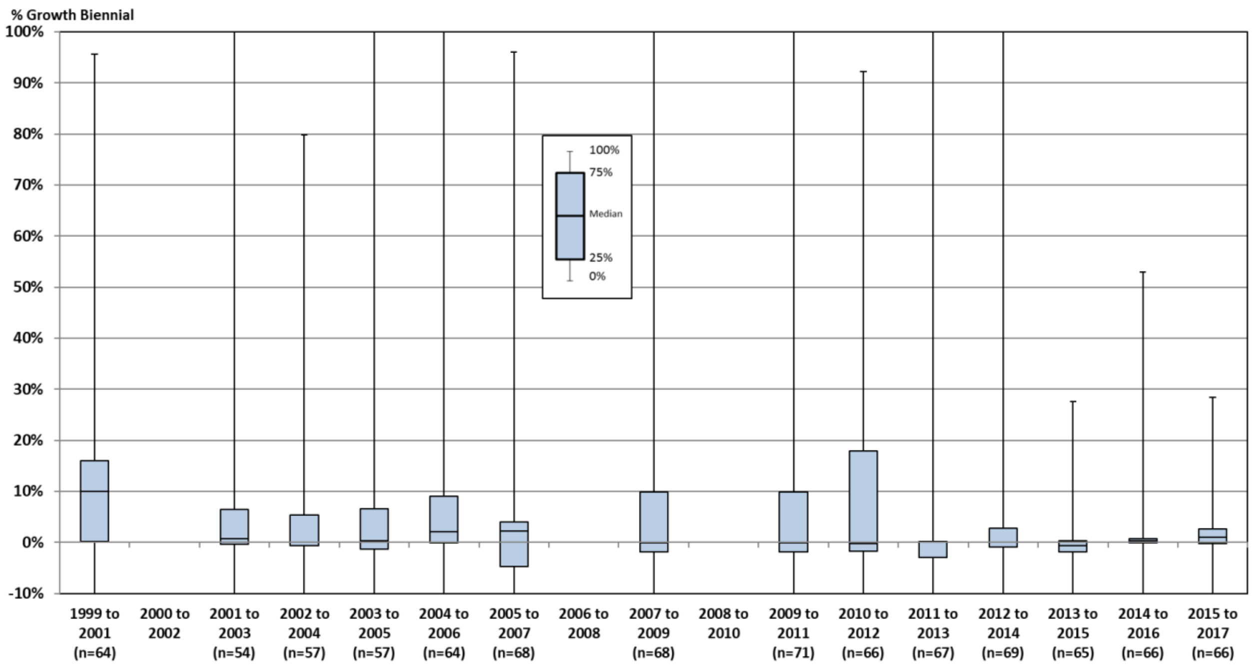


Median	3%		1%	1%	1%	1%	2%		0%		-1%	-1%	0%	0%	0%	0%	0%
IQR	20%		8%	7%	12%	13%	11%		10%		9%	5%	10%	6%	3%	4%	8%

NOTE: This shows biennial changes in unit recurring flyaway funding after adjusting for quantity changes; it is independent of RDT&E funding but reflects any work-content changes. These are percentage changes after adjusting for inflation and any quantity changes from original MS B baseline of actual past and estimated needed future funding as reported in the programs' latest SARs. Relatively new programs that have not spent at least 30 percent of their original EMD schedule are not included. Boxes show first quartile, median, and third quartile; bars show first and third quartiles, minimum, and maximum. The IQR is the difference between the 75th and 25th percentiles.
A number of items account for the differences between this figure and the analogous figure from USD(AT&L) (2016): addition of SDB I and JHSV data for all years when the programs were MDAPs and inclusion of a single F-35 data point for each year (via combination of aircraft and engine subprograms for years the SARs provided separate data) shown relative to the original F-35 MS B baseline account.

Figure 12. Biennial Procurement Cost Growth (Weighted by Program Size in Dollars):

Biennial Change in Active MDAP Planned Total (From Start to Completion)
Quantity-Adjusted Unit-Procurement Recurring-Flyaway Funding:
Dollar Basis (Controlled for Maturity; SAR Years 1999–2017)



SAR Year (n = # MDAPs in comparison)

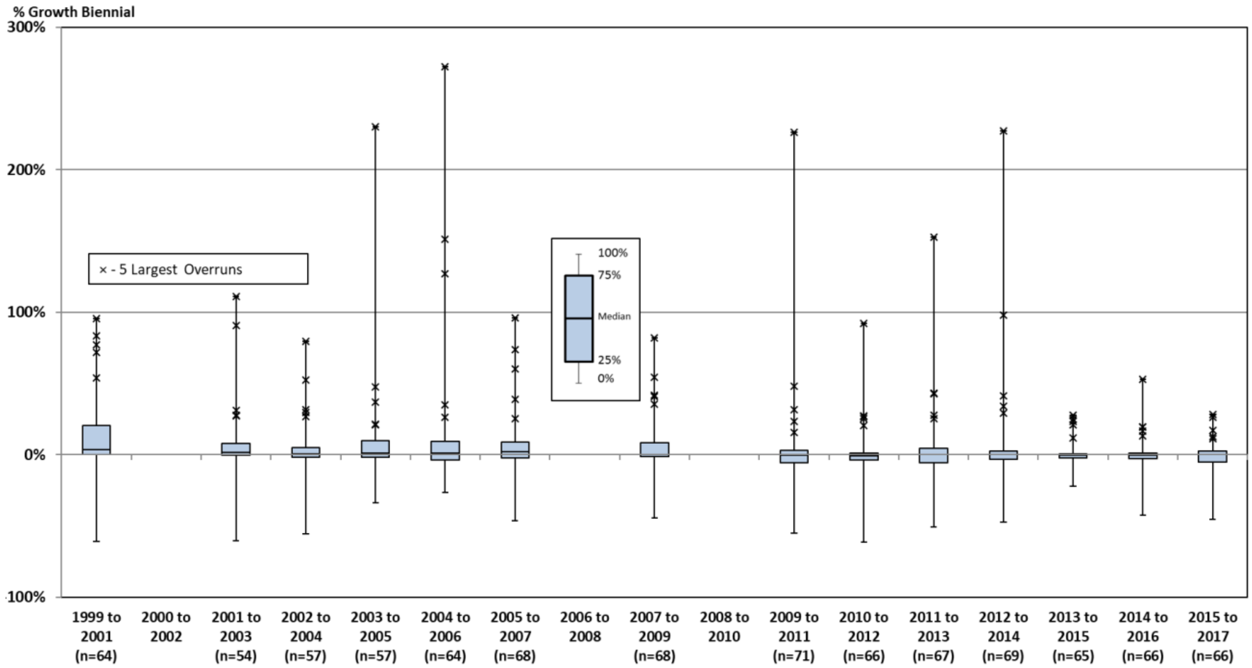
Median	10%		1%	0%	0%	2%	2%		0%		0%	0%	0%	0%	-1%	0%	1%
IQR	16%		7%	6%	8%	9%	9%		12%		12%	20%	3%	4%	2%	1%	3%

NOTE: This chart shows biennial changes in unit recurring flyaway funding after adjusting for quantity changes; it is independent of RDT&E funding but reflects any work-content changes. These are percentage changes after adjusting for inflation and any quantity changes from the original MS B baseline of actual past and estimated needed future funding as reported in the programs' latest SARs. Relatively new programs that have not spent at least 30 percent of their original EMD schedule are not included. Boxes show first quartile, median, and third quartile; bars show first and third quartiles, minimum, and maximum. The IQR is the difference between the 75th and 25th percentiles.
A number of items account for the differences between this figure and the analogous figure from USD(AT&L) (2016): addition of SDB I and JHSV data for all years when the programs were MDAPs, inclusion of a single F-35 data point for each year (via combination of aircraft and engine subprograms for years the SARs provided separate data) shown relative to the original F-35 MS B baseline, and correction of a deflator error account.

Figure 13 extends the y-axis scale to show all outliers in Figure 11, and the table at the bottom identifies the five largest funding-growth programs for each year.

Figure 13. Biennial Procurement Cost Growth Outliers:

Biennial Change in Active MDAP Planned Total (From Start to Completion)
Quantity-Adjusted Unit-Procurement Recurring-Flyaway Funding:
Program Basis Outliers (Controlled for Maturity; SAR Years 1999–2017)



SAR Year (n = # MDAPs in comparison)

Largest	CH-47F		SBIRS High	EELV	NPOESS		C-130 AMP		B-2 RMP		C-130 AMP	JTRS HMS	JPALS			SBIRS GEO 5-6	FAB-T FET
2nd Largest	ATIRCM CMWS		EELV	CH-47F	SBIRS High	LAND WARRIOR	EFV		AEHF SV 1-4		JTRS HMS	B-2 EHF Inc 1	MQ-8 Fire Scout			SDB II	LCS MM
3rd Largest	GMLRS AW		AEHF SV 1-4	SBIRS High	UH-60M	SBIRS High	NPOESS		MQ-8 Fire Scout		Excalibur	AEHF SV 1-4	AH-64E Reman	G/ATOR	RMS	MQ-4C Triton	SSC
4th Largest	MH-60R		TACTOM	AEHF SV 1-4	FCS	C-130 AMP	AEHF SV 1-4		AH-64E Reman		FAB-T	MQ-9 Reaper	AEHF SV 1-4	RMS	DDG 1000	AWACS Blk 40/45	G/ATOR
5th Largest	H-1 Upgrades		B-1B CMUP Computer	UH-60M	LAND WARRIOR	EFV	LHA 6		H-1 Upgrades		WGS	CH-53K	JTRS HMS	AH-64E Reman	SDB II	SSC	AWACS Blk 40/45

NOTE: This shows biennial changes in unit recurring flyaway funding after adjusting for quantity changes; it is independent of RDT&E funding but reflects any work-content changes. These are percentage changes after adjusting for inflation and any quantity changes from the original MS B baseline of actual past and estimated needed future funding as reported in the programs' latest SARs. Relatively new programs that have not spent at least 30 percent of their original EMD schedule are not included. Boxes show first quartile, median, and third quartile; bars show first and third quartiles, minimum, and maximum. X's mark the growth for the five largest outliers on each box-and- whisker chart. X's mark the growth for the five largest outliers on each box-and-whisker chart. Program abbreviations are defined in Appendix A.

A number of items account for the differences between this figure and the analogous figure from USD(AT&L) (2016): addition of SDB I and JHSV data for all years when the programs were MDAPs and inclusion of a single F-35 data point for each year (via combination of aircraft and engine subprograms for years the SARs provided separate data) shown relative to the original F-35 MS B baseline.

5. Schedule Performance: Development

Warfighting capabilities must not only have the needed technical performance but must be delivered in a timely fashion to address operational threats. Cycle time—the time between the identification of a need and fielding of a capability—therefore continues to be an area of primary concern.

We measure cycle time and schedule growth in various ways to gain insight into schedule-related performance. As we did with the cost growth analyses, we focus the analysis at the subprogram level. In some analyses (see Table 5 and Figure 14), we include only MDAPs that have already achieved the metric's endpoint (i.e., IOC). In other analyses (see Figure 15), we consider MDAPs that are underway or only recently achieved the endpoint. While ongoing programs might experience additional schedule growth before reaching their endpoints, including them might provide insight into recent trends. We also measure differences in both years and percent. The latter provides perspective on the relative magnitude of the change compared to the total length. Note, however, that percent scales differ below and above zero. The lowest negative value is −100 percent, while the largest positive value is theoretically (but not practically) infinity. Thus, −10 percent and +10 percent are not true inverses, and statistics such as the arithmetic mean (average) can be misleading when both negative and positive percent values are present in the distribution.

MDAP Cycle Time: MS B or MS C to IOC

We analyzed planned and actual cycle times for the 70 MDAP subprograms that reported achieving IOC (or a similar benchmark) in the SARs issued since 1997. Table 5 summarizes the average portfolio cycle time for these MDAPs. For MDAPs without an MS B/II, we used MS C/III dates. Not included are some MDAPs with complicated schedules that lacked clear or consistent program start or IOC-related dates as well as MDAPs whose earliest development or production APB was more than two newer than program start.[27]

Cycle times for these programs that achieved IOC grew across the portfolio by about 27 percent (16 months for a nominal 5-year program) compared to original plans. Programs that started at MS C had less schedule growth on average than those that started at MS B (9% versus 31%). While programs that started at MS C were shorter on average than those that started at MS B (actual cycle time of 3.9 years versus 7.7 years), some programs that started at MS B are among the shortest. The six longest programs all began at MS B and included EMD.

[27] The initial dataset contained 228 subprograms for which DAVE/DAMIR contained at least one development or production baseline and at least one SAR issued between 1997 and 2017. Of those, the analysis considered 70 to have achieved IOC either because the program had completed (and reported on the IOC MS in the last SAR) or because the program's most recent SAR (or the most recent SAR that reported on the IOC MS) was dated after that SAR's current IOC estimate. The analysis considered the 34 programs that had not yet obtained IOC but issued a 2017 SAR containing current estimates for both program start and IOC to be working towards IOC. The analysis excluded 58 of the original 228 programs because the earliest development or production APB in DAVE/DAMIR was dated more than two years after the program started. The analysis excluded an additional 11 programs because they did not contain an identifiable program start milestone. The analysis considered the remaining 55 programs to have reorganized or been cancelled prior to obtaining IOC. All F-35 schedule information resides with the Aircraft subprogram; the engine subprogram was not counted among the initial set of 228 subprograms.

Table 5. Average Portfolio Cycle Time (from MS B or C to IOC) for MDAPs Past IOC (1997–2017 SARs)

		Median *(years)*	Mean *(years)*	Count *(n)*	IQR *(years)*	Standard Deviation *(years)*	Min *(years)*	Max *(years)*
All Programs	**Planned**	**5.0**	**5.3**	70	3.9	2.5	0.8	12.3
	Actual	**6.9**	**6.8**	70	5.3	3.4	0.7	14.5
MS B Start	**Planned**	**5.8**	**5.9**	53	3.4	2.4	1.2	12.3
	Actual	**7.3**	**7.7**	53	3.8	3.2	1.1	14.5
MS C Start	**Planned**	**3.2**	**3.6**	17	2.3	1.9	0.8	7.5
	Actual	**3.5**	**3.9**	17	2.7	2.2	0.7	8.3

6 Shortest Programs *[subprogram]*	**Started at**	**Actual Cycle Time** *(years)*
JOINT MRAP	MS C	0.7
LUH	MS C	0.9
JTN	MS B	1.1
CEC	MS B	1.3
WIN-T INC 1	MS C	2.1
PAC-3 MSE	MS C	2.3

6 Longest Programs *[subprogram]*	**Started at**	**Actual Cycle Time** *(years)*
F-22	MS B	14.5
H-1 Upgrades	MS B	14.3
AEHF [AEHF SV 1-4]	MS B	13.8
F-35 [F-35 Aircraft]	MS B	13.8
C-5 RERP	MS B	12.3
LPD 17	MS B	11.8

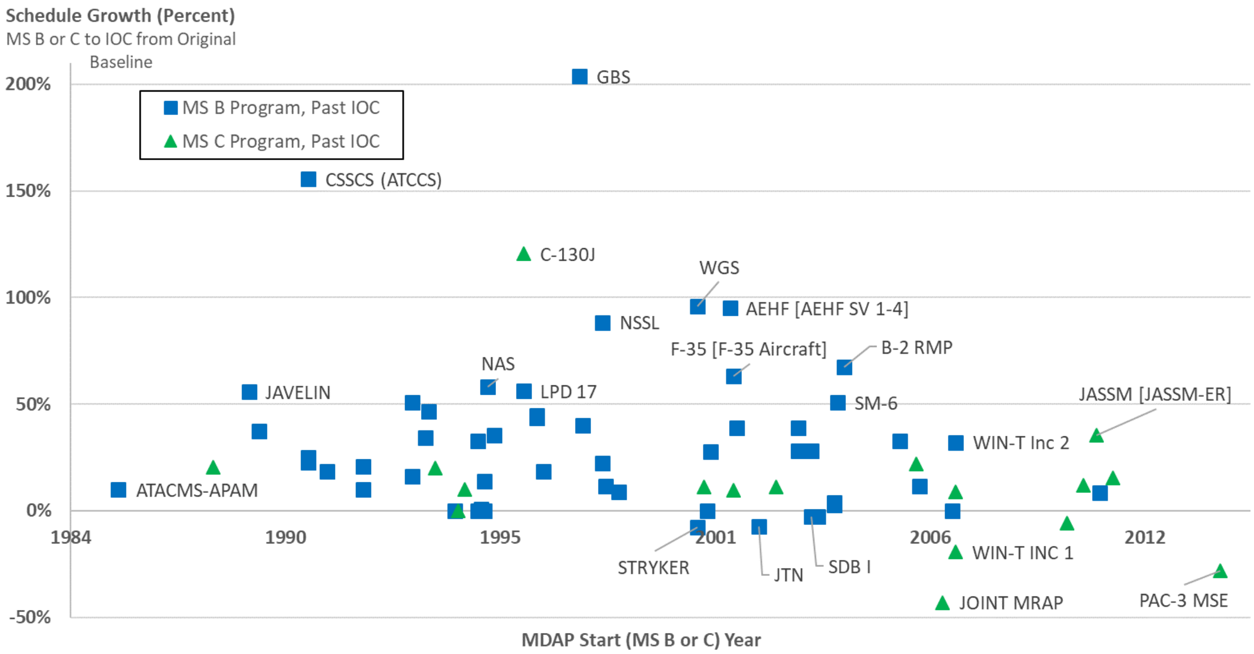
NOTE: The analysis used APBs as well as the 1997–2017 SARs. The analysis includes MDAPs with MS B or C dates as early as 1986. IOC dates range from August 1990 through July 2016. The planned cycle time is the time between the threshold values for program start (MS B or MS C as applicable) and IOC as reported in the earliest development or production APB in DAVE/DAMIR. The actual cycle time is the time between the current estimate for program start (MS B or MS C) and IOC as reported in the program's most recent SAR. For programs that did not identify program start or IOC milestones, the analysis used the most-equivalent milestones or excluded the program if equivalent milestones could not be identified.[28] A program was considered past IOC if the most recent SAR that reported on the IOC MS was dated after the current IOC estimate or if the program was complete and had reported on the IOC MS in the last SAR.[29] The IQR is the difference between the 75th and 25th percentiles. Program abbreviations are included in appendix A.
A number of items account for the differences between this table and the analogous table from USD(AT&L) (2016): exclusion of programs [subprograms] whose earliest APB in DAVE/DAMIR was issued more than two years after program start (MS B or MS C) due to the concerns that the APB might reflect the schedule at the time the APB was issued, not the time the program started and changes to the milestones deemed most equivalent to program start and IOC.

Figure 14 plots percent growth in development schedule versus program start date for the 70 MDAPs (or MDAP subprograms) that reported achieving IOC (or a similar benchmark) in the SARs issued since 1997.

[28] When available, the analysis used MS B, MS II, MS C, or MS III as the program start milestone. When available, the analysis used the following milestones (shown in the order of preference) as the end of the development cycle: initial operational capability, first-unit equipped, first asset delivery, required assets available, or any delivery milestone whose name did not include "prototype," "EMD," "LRIP," or similar terms. When a program did not include any of the preferred milestones, we selected the most-equivalent milestone manually. We excluded 11 programs for which we could not identify a start milestone.
[29] Some programs (e.g., COBRA JUDY REPLACEMENT, AESA) were 90% expended and issued their final SAR before IOC.

There was no statistically significant trend in schedule growth as a function of program start date for either MS B or MS C starts.[30]

Figure 14. Development Schedule Growth (from MS B or C to IOC) From Original Baseline for 70 MDAPs Past IOC (1997–2017 SARs)



NOTE: This figure plots percent growth in development schedule versus program start date for the 70 MDAPs (or MDAP subprograms) that reported achieving IOC (or a similar benchmark) in the SARs issued since 1997. The metric compares the actual cycle time, the time between program start (MS B or MS C as applicable) and IOC as reported in the program's most recent SAR, with the planned (baseline) cycle time reported in the program's earliest development or production APB in DAVE/DAMIR. For programs that did not identify program start or IOC milestones, the analysis used the most-equivalent milestones. A program was considered past IOC if the most recent SAR was dated after the current IOC estimate or if the program was complete.[31] The analysis excluded programs whose earliest developmental or production APB in DAVE/DAMIR was dated more than two years after the program started (MS B or MS C) due to the concerns that the APB might reflect the schedule at the time the APB was issued, not the time the program started. Program abbreviations are included in appendix A.
A number of items account for the differences between this table and the analogous table from USD(AT&L) (2016): exclusion of programs whose earliest APB in DAVE/DAMIR was issued more than two years after program start due to the concerns that the APB might reflect the schedule at the time the APB was issued, not the time the program started and changes to the milestones deemed most equivalent to program start and IOC.

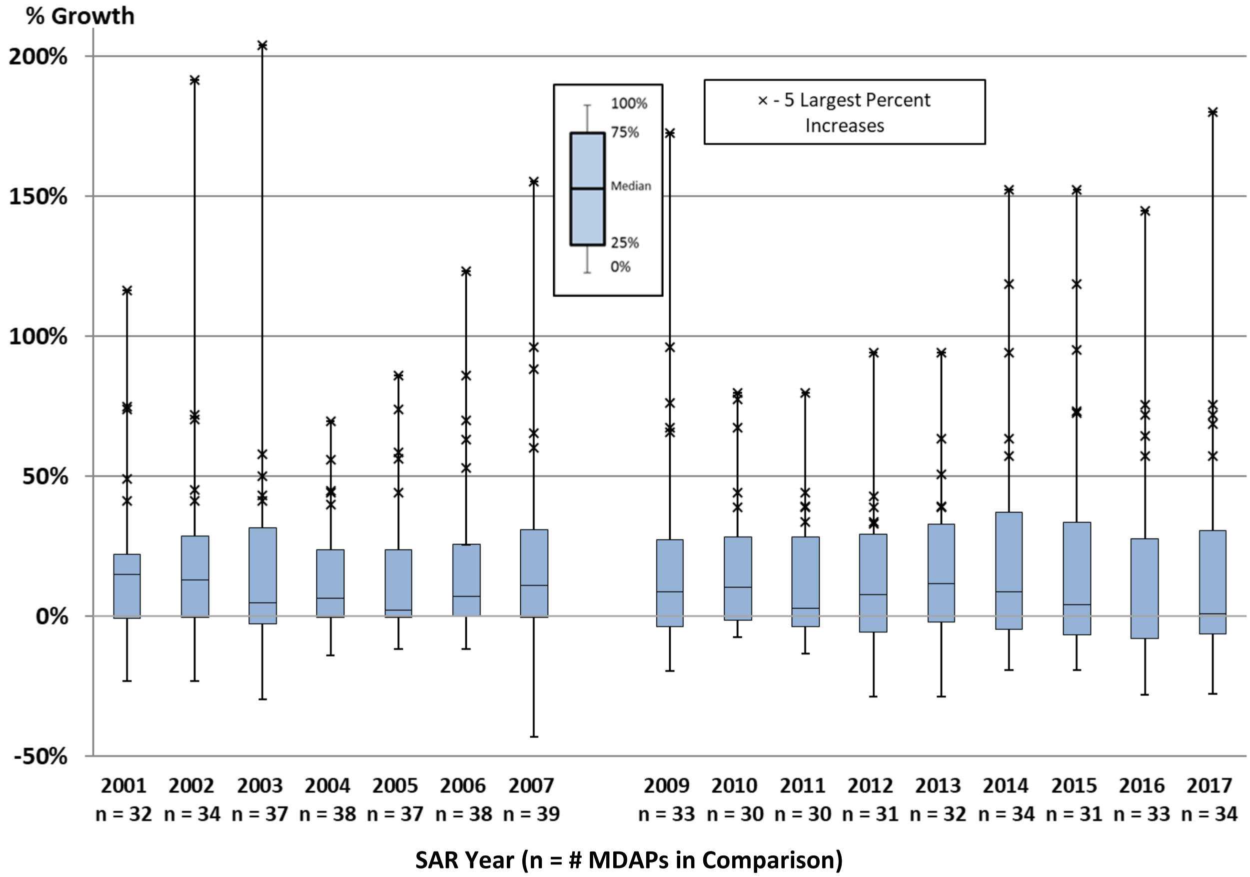
[30] We used a t-test with a significance cutoff of p=0.05 to assess whether the slope of the best affine model of percent schedule growth as a function of program start date was different from zero. We tested the MS B and MS C datasets separately.
[31] Some programs (e.g., COBRA JUDY REPLACEMENT, AESA) were 90% expended and issued their final SAR before IOC.

MDAP Schedule Growth: MS B or C to IOC

We also used SAR data to analyze the schedule growth of MDAPs working towards IOC. Figure 15 shows the distribution of schedule growth of the portfolio of active MDAP programs working towards or achieving IOC for each year.[32] Individual programs, of course, rotate in and out of the portfolio over time. The data for each year reflects the program managers' current estimates from the SARs; schedules may change in future years until the program achieves IOC. Median schedule growth dropped from 2015 to 2016, mainly due to a combination of programs with substantial schedule growth obtaining IOC (e.g., F-35, AEHF SV 1-4) or restructuring (e.g., JPALS)[33] and new programs starting (e.g., OASuW Inc 1, F-15 EPAWSS). While the median dropped, the overall distributions in 2015, 2016, and 2017 are not significantly different.[34]

[32] The analogous analysis in USD(AT&L) (2016) examined all active MDAPs in each year, including those in post-IOC production. To increase the sensitivity to recent trends and to equalize the impact of programs with long and short production runs on the results, this analysis only includes an MDAP up to the year it obtains IOC.
[33] In the 2016 SAR, JPALS defined a new IOC milestone and stopped reporting on the original IOC milestone, making schedule growth analysis for subsequent years infeasible using the present methodology.
[34] We used a Mann-Whitney test with a significance cutoff of 0.05 to compare the full distributions for each pair of years.

Figure 15. MDAP Schedule Growth (MS B to IOC From Original Baseline) for Active Programs Working Towards IOC (SAR Years 2001–2017)



Median	15%	13%	5%	6%	2%	7%	11%		9%	10%	3%	8%	12%	9%	4%	0%	1%
IQR	23%	29%	34%	24%	24%	26%	31%		31%	30%	32%	35%	35%	42%	40%	36%	37%

NOTE: This shows the changes in development schedule—program start (MS B or MS C) to IOC—for active programs working towards IOC. To emphasis recent changes, a program's schedule growth is not shown in the years after it achieves IOC. For each MDAP, the metric compares the schedule in each year's SAR to the schedule in the MDAP's first development or production APB in DAVE/DAMIR. Each program is weighted equally. For programs that did not identify program start or IOC milestones, the analysis used the most-equivalent milestones or excluded the program if equivalent milestones could not be identified. Programs are not included in years they did not issue SARs or issued SARs without current estimates for the program start and IOC milestones.[35] The IQR is the difference between the 75th and 25th percentiles.

A number of items account for the differences between this table and the analogous table from USD(AT&L) (2016): exclusion of programs whose earliest APB in DAVE/DAMIR was issued more than two years after program start due to the concerns that the APB might reflect the schedule at the time the APB was issued, not the time the program started; changes to the milestones deemed most equivalent to program start and IOC; and omission of data from years after a program obtained IOC.

[35] The analysis tracked milestones based on the Milestone_URI field in DAMIR/DAVE. We considered a milestone (e.g., IOC) in an APB and a SAR to be comparable if and only if both documents used the same Milestone_URI, regardless of how the definition of the milestone changed over time. When a program stopped reporting on the identified program start or IOC milestones, we considered the program to have reorganized to the point where the original and current schedules were no longer comparable.

Appendix A: Program Name Acronyms

Program Acronym[36]	Definition	Component
AAG	Advanced Arresting Gear	Navy
ABRAMS UPGRADE	M1A2 Abrams Tank Upgrade	Army
ACS	Aerial Common Sensor	Army
ACV 1.1	Amphibious Combat Vehicle Phase 1 Increment 1	Navy
ADS (AN/WQR-3)	Advanced Deployable System	Navy
AEHF	Advanced Extremely High Frequency Satellite	Air Force
AGM-88E AARGM	Advanced Anti-Radiation Guided Missile	Navy
AH-64E New Build	Apache New Build	Army
AH-64E Reman	Apache Remanufacture	Army
AIM-9X Blk II	Air Intercept Missile, Block II (Sidewinder)	Navy
AIM-9X BLOCK I	Air Intercept Missile, Block I (Sidewinder)	Navy
AMDR	Air and Missile Defense Radar	Navy
AMF JTRS	Airborne & Maritime/Fixed Station Joint Tactical Radio System	Army
AMF JTRS SALT	Small Airborne Link 16 Terminal	Army
AMF JTRS SANR	Small Airborne Networking Radio	Army
AMPV	Armored Multi-Purpose Vehicle	Army
AMRAAM	AIM-120 Advanced Medium Range Air-to-Air Missile	Air Force
ARH	Armed Reconnaissance Helicopter	Army
ASDS	Advanced Seal Delivery System	Navy
ASIP	Airborne Signals Intelligence Payload	Air Force
ATACMS-APAM	Army Tactical Missile System-Anti-Personnel Anti-Materiel	Army
ATACMS-BAT	Army Tactical Missile System-Brilliant Anti-Tank	Army
ATIRCM/CMWS	Advanced Threat Infrared Countermeasure/Common Missile Warning System	Army
ATIRCM/CMWS QRC	Quick Reaction Capability	Army
AV-8B REMANUFACTURE	Harrier II Remanufacture	Navy
AWACS Blk 40/45 Upgrade	Airborne Warning and Control System Block 40/45 Upgrade	Air Force
AWACS RSIP (E-3)	Radar System Improvement Program	Air Force
B-1B CMUP	Conventional Mission Upgrade Program	Air Force
B-1B CMUP DSUP	Defensive Systems Upgrade	Air Force
B-1B CMUP JDAM	Joint Direct Attack Munition	Air Force
B-2 DMS-M	B-2 Defensive Management System - Modernization	Air Force
B-2 EHF Inc 1	Extremely High Frequency SATCOM and Computer Increment 1	Air Force
B-2 RMP	Radar Modernization Program	Air Force
B61 Mod 12 LEP TKA	Mod 12 Life Extension Program Tailkit Assembly	Air Force
BLACK HAWK (UH-60A/L)	Black Hawk Utility Helicopter	Army
BFVS A3 Upgrade	Bradley Fighting Vehicle Systems A3 Upgrade	Army
C-130 AMP	Avionics Modernization Program	Air Force
C-130J	Hercules Transport Aircraft	Air Force
C-17A	Globemaster III	Air Force
C-27J	Joint Cargo Aircraft	Air Force
C-5 AMP	Avionics Modernization Program	Air Force
C-5 RERP	Reliability Enhancement and Re-engining Program	Air Force
CANES	Consolidated Afloat Networks and Enterprise Services	Navy
CEC	Cooperative Engagement Capability	Navy
CGS (JSTARS GSM)	Common Ground Station (Formerly JSTARS CGS)	Army
CH-47F	Improved Cargo Helicopter	Army
CH-47F Block II	Improved Cargo Helicopter, Block II	Army

[36] This table was adapted from USD(AT&L) (2016) and includes some programs that are not MDAPs.

Program Acronym[36]	Definition	Component
CH-53K	Heavy-Lift Replacement Helicopter	Navy
Chem Demil-ACWA	Chemical Demilitarization, Assembled Chemical Weapons	DoD
Chem Demil-CMA	Chemical Materials Agency	DoD
Chem Demil-CMA Newport	Chemical Materials Agency Newport	DoD
Chem Demil-CMA/CSD	Chemical Stockpile Disposal	DoD
Chem Demil-Legacy/NSCMP	Legacy/Non-Stockpile Chemical Materiel Project	DoD
CIRCM	Common Infrared Countermeasure	Army
COBRA JUDY REPLACEMENT	Cobra Judy Replacement	Navy
Comanche	Comanche Helicopter	Army
CRH	Combat Rescue Helicopter	Air Force
CVN 68	Nimitz Class Nuclear Aircraft Carrier	Navy
CVN 78	Gerald R. Ford Class Nuclear Aircraft Carrier	Navy
CVN 78/EMALS	Electromagnetic Aircraft Launching System	Navy
DCGS, Inc. 1	Distributed Common Ground System, Increment 1	Army
DDG 1000	Destroyer, guided-missile, Zumwalt class	Navy
DDG 51	Destroyer, guided-missile, Arleigh Burke class	Navy
DEAMS	Defense Enterprise Accounting and Management System	Air Force
DIMHRS	Defense Integrated Military Human Resources System	DoD
E-2C REPRODUCTION	E-2C Reproduction	Navy
E-2D AHE	Advanced Hawkeye Aircraft	Navy
EA-18G	Growler Aircraft	Navy
EA-6B ICAP III	Growler Aircraft, Improved Capability III	Navy
EELV	Evolved Expendable Launch Vehicle	Air Force
EFV	Expeditionary Fighting Vehicle	Navy
EPS	Enhanced Polar System	Air Force
ERM	Extended Range Munition	Navy
Excalibur	Excalibur Precision 155mm Projectiles	Army
F/A-18E/F	Super Hornet Aircraft, E/F variant	Navy
F-15 EPAWSS	Eagle Passive Active Warning Survivability System	Air Force
F-22	Raptor Advanced Tactical Fighter Aircraft	Air Force
F-22 Inc 3.2B Mod	Increment 3.2B Modernization	Air Force
F-35	Lightning II Joint Strike Fighter (JSF) Program	DoD
FAB-T	Family of Advanced Beyond Line-of-Sight Terminals	Air Force
FAB-T CPT	Command Post Terminal	Air Force
FAB-T FET	Force Element Terminal	Air Force
FBCB2	Force XXI Battle Command Brigade and Below Program	Army
FCS	Future Combat System	Army
FMTV	Family of Medium Tactical Vehicles	Army
G/ATOR	Ground/Air Task Oriented Radar	Navy
GBS	Global Broadcast Service	Air Force
GBSD	Ground Based Strategic Deterrent	Air Force
GCSS-A	Global Combat Support System, Army	Army
GMLRS AW	Guided Multiple Launch Rocket System/Alternative Warhead	Army
GPS III	Global Positioning System III	Air Force
H-1 Upgrades	Upgrades (4BW/4BN)	Navy
HC/MC-130 Recap	Recapitalization Aircraft	Air Force
HIMARS	High-Mobility Artillery Rocket System	Army
IAMD	Integrated Air and Missile Defense	Army
ICBM Fuze Mod	Intercontinental Ballistic Missile Fuze Modernization	Air Force
IDECM	Integrated Defensive Electronic Countermeasures	Navy
IFPC Inc 2-I Block 1	Indirect Fire Protection Capability, Increment 2, Intercept Block 1	Army
INCREMENT 1 E-IBCT	Increment 1 Early Infantry Brigade Combat Team	Army
IPPS-A	Integrated Personnel and Pay System, Army	Army
IRST	Infrared Search and Track	Navy
JAGM	Joint Air-to-Ground Missile	Army
JASSM	Joint Air-to-Surface Standoff Missile	Air Force
JASSM-ER	Extended Range	Air Force

Program Acronym[36]	Definition	Component
JAVELIN	Advanced Anti-Tank Weapon System, Medium	Army
JDAM	Joint Direct Attack Munition	Air Force
JHSV	Joint High-Speed Vessel	Navy
JLENS	Joint Land Attack Cruise Missile Defense Elevated Netted Sensor	Army
JLTV	Joint Light Tactical Vehicle	Army
JOINT COMMON MISSILE	Joint Common Missile	Army
JOINT MRAP	Joint Mine Resistant Ambush Protected Vehicle	Navy
JPALS	Joint Precision Approach and Landing System	Navy
JPATS	Joint Primary Aircraft Training System	Air Force
JSF	F-35 Joint Strike Fighter	DoD
JSOW	Joint Standoff Weapon	Navy
JTN	Joint Tactical Network	Army
JTRS GMR	Joint Tactical Radio System: Ground Mobile Radios	Army
JTRS HMS	Joint Tactical Radio System: Handheld, Manpack, and Small	Army
KC-130J	Transport Aircraft	Navy
KC-46A	Tanker Modernization	Air Force
Land Warrior	Land Warrior	Army
LCS	Littoral Combat Ship	Navy
LCS MM	Littoral Combat Ship Mission Modules	Navy
LHA	Amphibious Assault Ship (General Purpose)	Navy
LHA 6	America Class Amphibious Assault Ship	Navy
LHD	Amphibious Assault Ship (Multi-Purpose)	Navy
LHD 1 [LHD]	Wasp Class Amphibious Assault Ship	Navy
LONGBOW APACHE	Longbow Apache AH-64D Helicopter	Army
LONGBOW HELLFIRE	Longbow Apache Precision Strike Missile System	Army
LMP	Logistics Modernization Program	Army
LPD 17	San Antonio Class Amphibious Transport Dock	Navy
LSD	Dock Landing Ship	Navy
LUH	Light Utility Helicopter	Army
M88A2 HERCULES	M88A2 Heavy Equipment Recovery Combat Utility Lift	Army
MGUE Inc 1	Military Global Positioning System (GPS) User Equipment	Air Force
MH-60R	Multi-Mission Helicopter	Navy
MH-60S	Fleet Combat Support Helicopter	Navy
MHC 51	Coastal Mine Hunter	Navy
MIDS	Multifunctional Information Distribution System	Navy
MINUTEMAN III GRP [MMIII]	Minuteman III Guidance Replacement Program (GRP)	Air Force
MINUTEMAN III PRP	Minuteman III Propulsion Replacement Program (PRP)	Air Force
MOP GBU-57A/B	Massive Ordnance Penetrator Guided Bomb Unit	Air Force
MP-RTIP	Multi-Platform Radar Technology Insertion Program	Air Force
MPS	Mission Planning System	Air Force
MQ-1B UAS PREDATOR	Predator Unmanned Aircraft System	Air Force
MQ-1C Gray Eagle	Gray Eagle Unmanned Aircraft System	Army
MQ-4C Triton	Triton Unmanned Aircraft System	Navy
MQ-8 Fire Scout	Fire Scout Unmanned Aircraft System	Navy
MQ-9 Reaper	Reaper Unmanned Aircraft System	Air Force
MUOS	Mobile User Objective System	Navy
NAS	National Airspace System	Air Force
NAVSTAR GPS	NAVSTAR Global Positioning System	Air Force
Navy Area TBMD	Navy Area Theater Ballistic Missile Defense	Navy
NGJ Inc 1	Next Generation Jammer Mid-Band	Navy
NMT	Navy Multiband Terminal	Navy
NPOESS	National Polar-orbiting Operational Environmental Satellite	Air Force
OASuW Inc 1 (LRASM)	Offensive Anti-Surface Warfare Increment 1 (Long Range Anti-Ship Missile)	Navy
OCX	Next-Generation Operational Control System	Air Force
P-8A	Poseidon Multi-Mission Maritime Aircraft	Navy
PAC-3	Patriot Advanced Capability, variant 3	Army

Program Acronym[36]	Definition	Component
PAC-3 MSE	Missile Segment Enhancement	Army
Patriot/MEADS CAP	Patriot/Medium Extended Air Defense System Combined	Army
PIM	Paladin Integrated Management	Army
RMS	Remote Minehunting System	Navy
RQ-4A/B Global Hawk	Global Hawk Unmanned Aircraft System	Air Force
SADARM	Sense and Destroy Armor	Army
SBIRS Follow-On	Space-Based Infrared System Follow-On	Air Force
SBIRS High	Space-Based Infrared System High	Air Force
SBSS BLOCK 10	Space Based Space Surveillance Block 10	Air Force
SDB I	Small Diameter Bomb, Increment I	Air Force
SDB II	Small Diameter Bomb, Increment II	Air Force
SM 2	Standard Missile-2	Navy
SM-6	Standard Missile-6	Navy
Space Fence Inc 1	Space Fence Ground-Based Radar System, Increment 1	Air Force
SSBN 826	SSBN 826 COLUMBIA Class Submarine	Navy
SSC	Ship-to-Shore Connector Amphibious Craft	Navy
SSDS, MK 1	Ship Self-Defense System, Mark 1	Navy
SSDS, MK 2	Ship Self-Defense System, Mark 2	Navy
SSDS, MK 2 P3I	Ship Self-Defense System, Mark 2 Pre-Planned Improvement	Navy
SSGN	SSGN Ohio Class Conversion	Navy
SSN 21 / AN/BSY-2	SEAWOLF Class Nuclear Attack Submarine/Combat System	Navy
SSN 774	Virginia Class Submarine	Navy
STRATEGIC SEALIFT	Naval Transport Ship	Navy
STRYKER	Stryker Family of Vehicles	Army
T-45TS	Naval Undergraduate Jet Flight Training System (GOSHAWK)	Navy
TACTOM	Tactical Tomahawk RGM-109E/UGM-109E Missile	Navy
T-AKE	LEWIS and CLARK Class Dry Cargo/Ammunition Ship	Navy
T-AO 205 Class, T-AO(X)	John Lewis Class Fleet Oiler	Navy
TITAN IV	Space Booster	Air Force
TMIP-J	Theater Medical Information Program, Joint	DoD
Trident II Missile	Trident II (D-5) Sea-Launched Ballistic Missile UGM 133A	Navy
TSAT	Transformational Satellite Communications System	Air Force
TWS	Thermal Weapon Sight	Army
UH-60M Black Hawk	Black Hawk Helicopter	Army
V-22	Osprey Joint Services Advanced Vertical Lift Aircraft	Navy
VH-71	Presidential Helicopter Fleet Replacement	Navy
VH-92A	Presidential Helicopter	Navy
VTUAV	Vertical-Takeoff-and-Landing Tactical Unmanned Aerial Vehicle	Navy
WAS	Wide-Area Surveillance	Air Force
WGS	Wideband Global SATCOM	Air Force
WIN-T	Warfighter Information Network, Tactical	Army
WIN-T Inc 1	Warfighter Information Network, Increment 1	Army
WIN-T Inc 2	Warfighter Information Network, Increment 2	Army
WIN-T Inc 3	Warfighter Information Network, Increment 3	Army

Appendix B: Abbreviations

(See also the program names defined in Appendix A.)

ACAT—Acquisition Category

APB—Acquisition Program Baseline

APUC—Average Procurement Unit Cost

AT&L—Acquisition, Technology, and Logistics

C4ISR—Command, Control, Communications, Computers, Intelligence, Surveillance, and Reconnaissance

CY—constant year

DAMIR—Defense Acquisition Management Information Retrieval

DAVE—Defense Acquisition Visibility Environment

DoD—Department of Defense

EMD—Engineering, Manufacturing and Development

FY—fiscal year

IQR—interquartile range

MDAP—Major Defense Acquisition Program

MS—Milestone

NDAA—National Defense Authorization Act

PAUC—Program Acquisition Unit Cost

PB—President's budget (request)

RDT&E—Research, Development, Test, and Evaluation

SAR—Selected Acquisition Report

USD—Under Secretary of Defense

U.S.C.—United States Code

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